3 November 2016

RR Tool - Relative Risk Score Calculator

Report of the Society of Actuaries
Underwriting Criteria Team

Table of Contents

1 Overview

Principles Based Reserving (PBR) is expected to be introduced in 2017. The 2017 CSO mortality table and the underlying VBT experience table structures (beginning with the tables for 2015) were developed in conjunction with this change in reserving approach. One of the main features of PBR is to allow the calculated reserves to be based on actual experience, adding appropriate margins. To ensure risk equity in the U.S. life insurance markets, it has been historically common to evaluate life insurance risks as either standard or substandard. The premiums on policies covering individuals with a higher substandard mortality risk are then assessed an additional surcharge consistent with the higher mortality. To further improve the equity between premiums and risk, preferred Risk Structure programs became popular in the 1990s to more equitably stratify lives with standard mortality risks. This resulted in the introduction of fairly complex Preferred Risk Program structures to the individual life insurance market. These programs can vary significantly by life insurer writer.

The Relative Risk Tool (RR Tool) provides a standard relative risk score (RR Score) which can be used to create reasonably appropriate reserves for each of the preferred classes in the many different types of programs. This calculator is web based and available on the Society of Actuaries (SOA) website. This paper provides background of the RR Tool, including a description of the logic, inputs and creation of the assumptions used to produce the RR Score output. The actual assumption tables are provided in a separate Excel file, named "RR Tool Assumption Tables – 2016-08-18.xlsx". This file can be found on the SOA's website.

The RR Score provided by the RR Tool is an average industry estimate of the relative mortality of each of the risk classes defined by the various preferred risk programs used by individual life insurers. The RR Score is based on assumptions built into the calculator. It can be used as a guide in deciding on the appropriate 2015 VBT relative risk (RR) table to use for each risk class for valuation purposes. The RR Score are more significant when a company does not have enough credible mortality to determine the RR Score relative mortality experience from its own portfolio. The range of risk class definitions used in the market is very broad. The calculator provides reasonable expected relationships based on the individual preferred risk underwriting program definitions. It determines RR Scores and prevalences of each risk class based on the structure of any life insurer's specific preferred risk program. The RR Tool includes logic for both knock-out and debit-credit qualification approaches, as well as those using a combination of the two.

The RR Score is the early duration mortality of a particular risk class relative to the overall average portfolio mortality for all non-substandard risks at the same gender, age, smoking status and duration. The prevalence is the proportion of all standard risks expected to qualify for the particular risk class, again at the same gender, age, smoking status and duration.

In a best estimate reserving environment, to the extent experience is credible, actual experience should dictate the underlying assumptions, not the results of the RR Tool.

The RR Scores of the RR Tool are a good overall industry average starting point for assumptions, in the same vein that the VBT table is a good industry starting point for the overall mortality. Section 2 discusses the issue of industry and individual company results in more detail.

Lastly, the use of the word standard must be interpreted very carefully in this document and in the industry in general. The highest mortality risk classes in a preferred program are sometimes called something like residual or residual

standard. The use of the word standard in a preferred risk program can be confused with the term "standard" in a standard / substandard context. In the first stage of a risk evaluation process, lives are determined to be standard or substandard risks based on the evaluation of the circumstances of individual lives by underwriters. Only the risks determined to be "standard" qualify for a preferred risk programs. Therefore, all lives qualifying for that program are "standard" risks, regardless of the preferred class for which the individual qualifies. All of the preferred risk classes, whether super preferred, preferred, standard, or whatever other risk class names an insurer uses are standard underwritten risks.

2   Limitations of the RR Tool

The RR Tool is used to determine the RR Scores, which can be used to assist a carrier in the valuation process by determining the appropriate 2015 VBT RR tables for setting reserves for each or some risk classes.

The results of the RR Tool represents an industry average of the mortality outcome of using the preferred risk concept. This is conceptually similar to how mortality tables represent overall industry experience. The actual risk class experience will vary among many, if not most, life insurance carriers and from the results generated by the tool. Even when comparing only overall portfolio mortality experience, there are significant differences. The credibility of mortality experience of a single preferred class is even lower than for a carrier's entire portfolio, resulting in an even wider range of possible outcomes by class.

In addition, experience differences by insurer occur for reasons other than credibility, including many which are systematic. Some examples of reasons experience differ by insurer are:

Assumption granularity: The assumptions have been developed from an average insurance portfolio. They do not vary by characteristics such as gender, age, smoking status, and therefore do not reflect the granularity required for a pricing exercise. The inputs to the calculator use the above mentioned characteristics only to reflect differences based on those characteristics in the preferred risk criteria.

Logic limitations: The formulas used to calculate the impact of the interaction among the criteria are reasonable, but based only on broad industry assumptions. Also, there could be actual overlaps of the impact of both the relative risks and prevalences among many of the criteria. However, the formulas assume completely independent relationships.

Company specific attributes: The results are based on life insurance industry overall average experience. The actual experience for individual carriers could deviate from the calculated values. Differences can be due to a wide variety of different factors.

There are many factors and conditions not reflected in the calculator which will impact individual companies experience uniquely. A non-comprehensive list includes items such as:
- Target market,
- Distribution methods,
- Company underwriting and claims standard practices,
- Company ad hoc business exceptions, and

- Inclusion of non-standard risk criteria used in some preferred risk programs.

Companies use various smoker definitions. Definitions usually vary in two aspects:
- Cigarette smokers only disqualify vs. any nicotine use disqualifies, and
- The minimum number of years the individual has not smoked or used tobacco before qualifying for the non-tobacco class.

Although the tool includes inputs for tobacco definition, it is not reflected in this version of the tool.

Preferred risk program structures: The calculator is designed to reflect most, but not all, common preferred risk structures. Some companies may use criteria not included in the RR Tool. The program includes logic for debit-credit approaches using formulas where the impact is measured by adding or subtracting points. However, it is quite possible that other approaches could be devised. Structures which allow occasional cigar smokers to qualify for non-smoker classes are not supported. Exception offset qualifications used in some knock-out programs are not supported. The definitions of some types of restrictions (e.g. – aviation, avocation) vary by insurer. The varying impact of the different definitions are not explicitly recognized. Lastly, the calculator does not reflect potential insurance applicant self-selection impacts in highly competitive markets. In a market with multiple preferred risk programs, each with a different qualification structure, the applicant will tend to choose policies from programs more advantageous to their particular situation.

Data sources used to create assumptions: The main data sources used to create the underlying assumptions come from "Applied for" policies. Reserves however, are calculated on issued policies. This could create biases for which it is not currently possible to adjust. If "Not taken" rates are biased, the mortality risk distribution of the portfolio of policies applied for would be different than that of policies issued. It is quite possible that the "not taken" rates for policies at the higher end of "standard underwritten" mortality risks will be higher than policies with the lower mortality risks. It would be useful to study this behavior for future versions of the calculator.

3 Preferred risk program structure options

Preferred risk programs have several structure dimensions:

Number of risk classes: The calculator allows a single program to have up to six non-smoker and six smoker classes. When this document refers to the number of classes, it includes the standard/residual class as one of the classes. As well, the number of classes is always counted separately for non-smokers and smokers.

Qualification scoring method: Scores for both knock-out (K/O) and debit-credit (D/C) preferred underwriting approaches are calculated consistently. Calculations for programs which use a mix of K/O and D/C qualifications can also be handled.

Qualification categories: The list of available qualification categories is provided in Table 1 below. Family history, personal history and Other categories allow for up to two additional categories.

Qualification category limit values: Table 1 shows the risk class measurement types and the range of possible minimum and maximum values that a program may use for qualification limits.

Measurement types: This column indicates the types of information used to define the qualification standards of each criterion.

Industry standard minimum / maximum values: This column defines the industry normal range of risk class qualification values which would not disqualify a life to be a "standard underwritten" risk. If the specific program has overall program (not individual preferred risk class) minimum and maximum values equal to those shown in this column, the cumulative weighted RR Scores is equal to 100%, and the combined prevalence of all classes is equal to 100%. If the overall program minimum or maximum (combined minimums and maximums of all risk classes combined) does not equal these industry standard values, the average RR Score across all preferred risk classes could be greater or less than 100%. An example of this is shown in the Build example below in Section 5.8.

Although this committee included actuaries, underwriters and medical directors, the "industry standard" values were determined somewhat subjectively and certainly will have a range of opinions as to their appropriateness. These definitions are worth revisiting in the future.

Assumption table minimum / maximum values: This column provides the range of possible program qualification levels for which relative risks and prevalences are included in the calculator's assumption tables. Risk class restriction limits are restricted to the values shown in the "Assumption table minimum/maximum values" column. Values outside this range will have no impact on the calculation results. For example, if the Build program minimum value indicated is a BMI of 42, the RR Tool resets it to a value of 40 (the assumption table minimum BMI value for Build shown in the table below). Choosing overall program limiting criteria restriction values more liberal than the industry standard values will increase the overall mortality of the program. Stricter restrictions will decrease the overall mortality of the program.

Table 1: Preferred risk criteria qualification types

Risk Criteria	Measurement types	Industry standard minimum / maximum values	Assumption table minimum / maximum values
Blood pressure – diastolic (DBP)	DBP values (being treated for high BP and not under treatment)	{55/95}	{55/100}
Blood pressure – systolic (SBP)	SBP values (being treated for high BP and not under treatment)	{85/145}	{85/155}
Build	Body Mass Index (BMI) or equivalent height/weight	{15.1/35.0}	{14.1/40.0}
Cholesterol ratio (CR)	CR value (being treated for high cholesterol levels and not under treatment)	{2.0/9.0}	{2.0/10.0}
Cholesterol total (TC)	Total cholesterol value (being treated for high cholesterol levels and not under treatment)	{131/275}	{110/290}

Risk Criteria	Measurement types	Industry standard minimum / maximum values	Assumption table minimum / maximum values
Driving record (Moving violations)	Maximum number of violations forgiven	{0-3}	{0-3}
	No. of years record reviewed	{1-5}	{1-5}
	Flat extra ratings allowed	Yes, No	Yes, No
Driving record (Driving under influence / Reckless driving)	Maximum number of violations forgiven	1 when 10+ years ago, 0 when within last 9 years	{0-3}
	No. of years record reviewed	{1-10, 11+}	{0-10,11+}
	Flat extra ratings allowed	Yes, No	Yes, No
Family medical history (FamHx) - Cancer, cerebrovascular, coronary, diabetes, additional; all separately	Event definition: death only or death/disability	Death / Death or disability	Death / Death or disability
	Family relationships considered	Parent/Parent-siblings/Parent-siblings-other	Parent/Parent-siblings/Parent-siblings-other
	Maximum no. of events forgiven	{0-2}	{0-2}
	Maximum age at time of onset of condition for event to be considered	{50, 55, 60, 65, 70}	{50, 55, 60, 65, 70}
	No of additional conditions (only for "FamHx additional conditions")	{0}	{0, 1 ,2}
	Description (description of additional conditions	For documentation only	For documentation only
Personal medical history (PerHx) - Cancer, cerebrovascular, coronary, diabetes, mental/nervous, additional; all separately	Restriction definition	No history of disease, No ratable disease, No net (dr-cr) ratable disease, Ratings allowed	No history, No ratable disease, No net (dr-cr) ratable disease, Ratings allowed
	No of additional conditions (only for "PerHx additional conditions")	{0}	{0, 1 ,2}
	Description (description of additional conditions	For documentation only	For documentation only
Substance abuse – alcohol	No. of years of record reviewed	{7-20}	{1-20+}
Substance abuse – drugs	No. of years of record reviewed	{5-20+}	{1-20+}
Other restrictions (Aviation, avocation, citizenship, foreign travel, occupation, residency, additional; all separately)	Restriction used	Yes / No	Yes / No
	No of additional conditions (only for "Other additional conditions")	{0}	{0, 1 ,2}
	Description (of additional conditions only)	For documentation only	For documentation only

A clarification is needed to table 1 above:

<u>Personal Medical History options:</u>
"No history of disease" indicates that the insured has never had the disease.

"No ratable disease" indicates that the insured may have or have had the disease, but not to the level of requiring a table or flat extra rating. This disease would result in a disqualification for eligibility in the risk class in a K/O structure or in the assessment of the allocated points in a D/C preferred structure.

"No net (dr-cr) ratable disease" is a slight variant of the "No ratable disease" standard. The insured who has had the disease would be disqualified only if there is a presence of any **net** positive debits minus credits in the underwriting review process. In other words, underwriting credits are allowed as offsets to any assessed debits.

"Ratings allowed" indicates that the insured would not be disqualified if ratings are assessed on the policy.

4   Assumption development

Relative risk and prevalence assumptions were developed for each preferred risk evaluation criterion. They were constructed from several sources as shown in Table 2 and explained in the paragraphs immediately below. Since substandard risks are not eligible for preferred programs, the impacts of substandard risks were excluded to the extent possible. The base assumptions represent only standard risks. The assumption table contains values of certain criteria beyond normal industry standards for situations when a particular carrier has liberal standards in determining whether a risk is substandard. The impact of substandard risks not due to the specific risk evaluation criterion are not included in the assumptions for that criterion.

The actual relative risk and prevalence assumptions for each preferred risk evaluation criterion are provided in the Excel file, "RR Tool Assumption Tables – 2016-08-18.xlsx". The "3. Tables" worksheet contains all the criteria except blood pressure and cholesterol. The blood pressure assumptions used in the calculator are stored in worksheet "1. Blood Pressure". Cholesterol assumptions are provided in worksheet "2. Cholesterol". The diastolic and systolic blood pressure, total cholesterol and cholesterol ratios provided in worksheet "3. Tables" were used to create the assumptions in worksheets "1. Blood Pressure" and "2. Cholesterol" and the tool accesses those assumptions through these tables.

Lab database: A fluid testing lab provided its insured life applicant test results and other information collected by the paramedic collecting the specimens. This database was augmented for mortality information from the Social Security Death Master File by the lab directly. The file was then depersonalized for this analysis. The data contained approximately 55,000 deaths and 4.5 million lives, collected for the calendar years between 2000 and 2010.

Large direct individual life insurer database: A large direct individual life insurer which has stored underwriting data over many years provided an analysis of its data.

RGA published study and additional information: RGA's paper analyzes the predictive value of motor vehicle reports on all cause mortality[10]. The data was obtained from LexisNexis. The results of that study were published in

a paper which together with additional information from both RGA and LexisNexis, was used to develop the assumptions for the various Driving Record criteria.

Medical studies and professional judgment: Various members of the Underwriting Criteria Team (UCT) made professional judgment estimates of the predictive value of certain criteria. In some cases, the results of non-insurance related medical studies were considered. The UCT included actuaries, underwriters and medical doctors. Because the additional criteria are not known, the assumptions for family history – cardiovascular were used for each additional family history condition, personal history – mental/nervous for each additional personal history condition and Other – aviation for each additional other category.

The derivation of prevalences and RR Scores for Family History of each disease were based on a combination of clinical literature, professional judgment, and the experience of a large direct life insurer. Applicable clinical sources for family history of coronary[1,2,3,4,5] or cerebrovascular disease[1,6], were generally more relevant than those for cancer[7,8] or diabetes[9].

The clinical studies have several shortcomings for this purpose:
1. The study cohort was typically older than an insured population,

2. The criteria use one fixed age of premature event for the family member,

3. The criteria use either disease or death as an outcome but typically not both, and

4. There was no real test of independence, e.g. of each parent dying.

For ease of implementation, the RR Scores for each dimension within the disease were derived and then combined (multiplicatively) as if independent.

Table 2: Data sources underlying assumptions

Criterion	Category	Data Source
Blood Pressure	Diastolic	Lab database
	Systolic	Lab database
Build	BMI & Height-Weight	Lab database
Cholesterol	Total	Lab database
	Ratio	Lab database
Driving Record	Moving Violations	RGA published study and additional information
	Driving under influence	RGA published study and additional information
	Reckless Driving	RGA published study and additional information
Family History	Cancer	Professional judgment
	Cerebrovascular	Large direct life insurer database
	Coronary	Large direct life insurer database
	Diabetes	Professional judgment
	Additional	Professional judgment
Personal History	Cancer	Prevalence - Large direct life insurer database; Relative mortality – professional judgment
	Cerebrovascular	Prevalence - Large direct life insurer database; Relative mortality – professional judgment
	Coronary	Prevalence - Large direct life insurer database; Relative mortality – professional judgment
	Diabetes	Prevalence - Large direct life insurer database; Relative mortality – professional judgment
	Mental/Nervous	Prevalence - Large direct life insurer database; Relative mortality – professional judgment
	Additional	Professional judgment
Substance Abuse	Alcohol	Large direct life insurer database
	Non-prescription drugs	Large direct life insurer database
Other	Aviation	Professional judgment
	Avocation	Professional judgment
	Citizenship	Professional judgment
	Foreign Travel	Professional judgment
	Occupation	Professional judgment
	Residency	Professional judgment
	Additional	Professional judgment

5 Logic

5.1 General

a. The formulas used in all calculations assume independence among criteria.

b. Separate calculations are completed for non-smokers and smokers and for each defined age range in steps 5.2 to 5.8 below. The results for each of the age ranges are combined in step 5.9. Non-smoker and smoker criteria are never combined. Separate RR Scores are produced for non-smokers and smokers. These are based solely on the differences in risk class qualifications.

c. The Tool allows for up to six age ranges, defined at the overall program level, for each of non-smokers and smokers.

5.2 Determine the RR Scores and prevalences of all individual criteria based on Knock-out (K/O)

a. The first step of the calculation is to calculate the RR Score and prevalence impact of all criteria based on the definitions defined by the user in the criteria sections.

  o If a specific risk criterion is not used in a particular preferred risk program, the RR Score and prevalence impact of the criterion are both set to 100% for the best mortality risk class. The values for all other risk classes are set to 0. The calculation method is the same for all criteria. Although, only two representative examples are shown later in this section, the process is the same for all criteria. Calculations are determined independently for each criterion.

  o This step uses the same logic for both knock-out and debit-credit structures. The only difference is that in the knock-out structure, the user inputs the risk class. If the qualification method for this criterion is debit-credit, the user is prompted to input the assigned number of D/C points.

  o Cumulative RR Scores and prevalences are extracted from the assumptions table ("RR Tool Assumption Tables – 2016-08-18.xlsx") for the particular criterion based on the qualifications inputted by the user in the criteria sections.

    For criteria where the qualifications are numeric (such as BMI, blood pressure, cholesterol), only the upper limit needs to be input. The lower limit is defined by upper limit of the prior definition.

    The "Program" minimum restriction values are used to define the lower limit of the lowest value qualification range.

It is possible that the qualification limit does not exactly match one of the qualification values stored in the assumption table. In this case, the RR Scores and prevalences are determined by linearly interpolating between the adjacent qualification values stored in the assumption table. For example, the assumption table stores the RR Scores and prevalence assumptions for BMIs of 35 and 40. If the defined qualification BMI limit for a specific risk class is 37, the cumulative RR Scores and prevalences for 37 are calculated using 60% of the 35 BMI and 40% of the 40 BMI table assumptions.

b. The next step is to calculate the range RR Scores and prevalences of each of the qualification ranges inputted by the user using the cumulative RR Scores and prevalences determined in step a above.

Table 3 below provides an example of a BMI calculation. The "cumulative" values are obtained from the assumption table. The "range" prevalence is the difference between the cumulative prevalence for that input less the cumulative prevalence for the next lower restriction. The range RR Score is the sum-product (weighted by the appropriate prevalences) difference between the two adjacent RR Scores.

Two of the underlying assumptions (Build and cholesterol) have a built-in J-curve (or U-curve) relative risk structure. This occurs when low and high values increase expected mortality. The sample build structure

below shows the impact of structuring a set of risk class qualifications which reflect the higher expectations for both high and low BMIs.

Table 3 Build - Sample calculation/O qualification structure

Program input values		Determined by calculator					
Risk class*	Maximum qualification value	Minimum BMI qualification	Maximum BMI qualification	Cumulative values from assumption table		Calculated range values	
				RR Score	Prevalence	RR Score	Prevalence
Program max	35	BMIs of 35.1 and higher do not qualify as standard risks		100.0%	100.002%	-	0.00%
Std	35	30.1	35.0	100.0%	100.002%	128.0%	11.903%
Pref	30	27.1	30.0	96.2%	88.099%	100.5%	26.595%
Pref+	27	20.1	27.0	94.4%	61.504%	93.7%	59.778%
Std	20	15.1	20.0	118.1%	1.726%	118.0%	1.724%
Program min	15.1	BMIs 15.0 and lower do not qualify as standard risks		227.6%	0.002%	-	-

*The risk class names shown in this column are defined by the user in the criteria sections

The columns "Risk class" and "Maximum qualification value" are defined by the user in the Build section of the criteria input.

The maximum and minimum BMI qualifications are determined using the inputted maximum values. It shows that individuals with BMIs between 30.1 – 35.0 or 15.1 – 20.0 can now qualify for no better than the Std (standard) class. Those with BMIs in the range 27.1 – 30.0 qualify for no better than the Pref (preferred) class. BMIs between 20.1 and 27.0 can still qualify for the Pref+ (Preferred+) risk class. BMIs of 35.1 and higher or 15.0 and lower are not "standard underwritten" risks and would have a substandard rating added to the premium.

The RR Score and Prevalence numbers in the "Cumulative values from assumption table" columns are taken from the assumption tables, based on the Maximum qualification values" in the second column.

The RR Score and Prevalence numbers in the "Calculated range values" are calculated using the corresponding cumulative values. Range prevalences are the cumulative prevalences in the same row minus the cumulative prevalence in the row immediately below. Range RR Scores are similar, except that the calculation is weighted by the attached prevalence. Although the RR Score and prevalence values shown are to 1 and 3 decimal places in the table, the calculation does not round any values at this stage.

c. In the example in Table 3, the "Std" risk class qualification occurs in two separate ranges "30.1-35.0" and "15.1-20.0" Table 4 below shows how the RR Scores and prevalences for the two sections can be combined so that there is only one RR Score and prevalence value for the Std risk class. This means that 13.627% of the total population will be classified as "Std" due to the BMI restrictions, and the average RR Score of this group is 126.7%. For efficiency, the standard/residual impact of the BMI restrictions is an RR Score of 126.7% and a prevalence of 13.627%.in the calculation. It makes no difference that the restriction is defined in two separate sections.

Table 4   Build - Combining multiple ranges assigned to same risk class

Risk class	Minimum BMI qualification	Maximum BMI qualification	Calculated range values	
			RR Score	Prevalence
Total "Std"			126.7%	13.627%
Std	30.1	35.0	128.0%	11.903%
Std	15.1	20.0	118.0%	1.724%

d.   The values in Table 5 are the final BMI RR Score and prevalence impact values used in the next stage of the calculations.

Table 5 K/O Build RR Scores and prevalences impact on final classification

Risk class	*Calculated range values*	
	RR Score	*Prevalence*
Std	126.7%	13.627%
Pref	100.5%	26.595%
Pref+	93.7%	59.778%

e.   Example 2 – Driving record (DUI and Reckless Driving)

The first five columns in Table 6 are the DUI/RD driving record limiting restriction inputs used in this example. In this case, only specifications for the Pref class were inputted. The "Cumulative assumption table values" are the cumulative RR Score and prevalence values obtained directly from the DUI/RD assumption table based on these inputs. The calculation process for the range RR Score and prevalence values is the same as was described in the BMI section above.

Table 6 Sample Driving Record (DUI and Reckless Driving)

Values defined by user					Cumulative values from assumption table		Calculated range values	
Risk class	Risk type	No. of yrs reviewed	No. of allowed events	Flat extras allowed				
					RR Score	Prev	RR Score	Prev
Std					100.0%	100.000%	177.6%	3.935%
Pref	DR	10	0	Y	96.8%	96.065%	96.8%	96.065%

f.   Driving record requires four sets of information to define the qualification criteria. The cumulative values are obtained from the assumption table. The calculated range values are determined consistently with the Build calculations.

g.   It should be noted that Table 6 does not have a limiting restriction for the Pref+ risk class. Therefore because there is no further restriction, any individual that qualifies for the Pref class, also qualifies for the Pref+ class. Table 7 shows the risk class impact of the DUI/RD qualification restriction as defined in Table

6.

Table 7   K/O Driving Record - Values transferred to next step

Risk class	Calculated range values	
	RR Score	Prev
Std	177.6%	3.935%
Pref		0.000%
Pref+	96.8%	96.065%

5.2.1 Build special calculations

Build criterion risk class qualifications can be input two ways, either as BMI or height/weight. The underlying assumptions are provided on a BMI basis. It is common to provide the qualifications using the height/weight approach because this is more understandable to the client. The table can be quite large. To simplify the input, the weights for three standard heights for males and three for females are used in the calculation. For males, the weights for heights of 5' 6", 5' 10" and 6' 2' are required. For females, the heights are 5' 2", 5' 6" and 5' 10" are needed. The whole process requires three steps.

1. Conversion from height/weight to BMI: The formula BMI = 703 * weight (lbs) / (height (inches)^2). The original BMI formula is BMI = Weight (kg) / Height (m)^2. If BMI is input directly, this step is skipped.

2. The converted BMIs are then weighted 25%, 50% and 25%, respectively, as approximations for the proportion of individuals at each height. If BMI is input directly, only one BMI value is used. Therefore, there is no need to weight multiple values. In that case, this step is skipped.

3. Male and female results are then combined into a single value using expected claims as a weight. The expected claims weights are calculated using the process and values described in section 5.9 of this report.

5.2.2 "Treated" for Blood Pressure and Cholesterol

Some programs treat blood pressure or cholesterol restriction levels differently. The input sections for these risk criteria have a special list of options on how qualifications for individuals being treated for blood pressure or cholesterol are defined.

1. *"Treatment disallowed"* - All individuals being treated for the condition automatically only qualify for the "Standard-Residual" risk class. This option is not allowed for debit-credit approaches.

2. *"No treatment restriction differences"* – The same restrictions are applied for individuals whether they are being treated or not.

3. *"Treatment restriction values differ from untreated"* - Different restrictions are applied to individuals who are being treated and those who are not under treatment.

5.3 RR Score and prevalence aggregations of all K/O based criteria qualifications

The next step is to aggregate the results of all of the individual criteria. Mathematically, it is easiest to add the impact of the criteria, one at a time.

The K/O logic says that the class for which the risk qualifies is the worst (highest mortality) class for which it qualifies under any of the single criteria standards.

Formulaically, the impact of each criterion is added one at a time. Initially, before any risk criteria are applied, all risks qualify for the best preferred class. Then, as each criterion is applied, the qualification of some of the risks deteriorate because of the impact of that specific restriction.

Table 8 describes the calculation approach used to accomplish this. Step NA is not really a step. It is simply the impact of the first criterion being considered. Step 1 then combines the impacts of the first and second risk classes. The result is aggregation 1. Step 2 then adds the impact of criterion 3, resulting in aggregation 2. This continues until all criteria have been reflected. Table 8 lists only a few criteria. However, all criteria need to be included in the process. It should be noted that the actual order of adding the criteria does not change the final overall impact after all criteria have been included in the calculation.

The final impact from K/O criteria is the expected distribution (prevalence) and RR Scores once all of the individual impacts of all risk classes have been included.

Table 8 K/O classes aggregation steps

Step	Group 1	Group 2	Result
NA	Build	All risks in best preferred	Build
1	Driving	Build	Aggregation 1
2	Blood Pressure	Aggregation 1	Aggregation 2
3	Cholesterol	Aggregation 2	Aggregation 3
4	Family History – Cancer	Aggregation 3	Aggregation 4
5, 6, …	Next criterion	Prior aggregation	Next aggregation

Table 9 shows an example of the logic used in aggregating Groups 1 (in this case, Driving Record (MVR)) and 2 (in this case, Build) using the results from the numerical values shown in tables 5 (driving record) and 7 (build) above.

The logic shown in Table 9 is also used to add the impact of all other criteria, one by one, into the overall result.

The "Combined Risk Class" is the worst (higher mortality) risk class from either the Build Risk Class or the Driving Risk Class. This is consistent with the K/O qualification approach that a life qualifies for the risk class only if it qualifies for that class in all criteria. The Combined RR Score is the product of the Build RR Score and the Driving RR Score. The Combined Prevalence is the product of the Build Prevalence and the Driving Prevalence. All of the Build and Driving columns are the values already shown in Tables 5 and 7.

Table 9 Combining the K/O results from tables 5 and 7

Risk Class			RR Score			Prevalence		
Build	**Driving**	**Combined**	**Build**	**Driving**	**Combined**	**Build**	**Driving**	**Combined**
Std	Std	Std	126.7%	177.6%	225.1%	13.627%	3.935%	0.536%
Std	Pref	Std	126.7%	0.0%	0.0%	13.627%	0.000%	0.000%
Std	Pref+	Std	126.7%	96.8%	122.7%	13.627%	96.065%	13.091%
Pref	Std	Std	100.5%	177.6%	178.6%	26.595%	3.935%	1.047%
Pref	Pref	Pref	100.5%	0.0%	0.0%	26.595%	0.000%	0.000%
Pref	Pref+	Pref	100.5%	96.8%	97.3%	26.595%	96.065%	25.548%
Pref+	Std	Std	93.7%	177.6%	166.4%	59.778%	3.935%	2.352%
Pref+	Pref	Pref	93.7%	0.0%	0.0%	59.778%	0.000%	0.000%
Pref+	Pref+	Pref+	93.7%	96.8%	90.7%	59.778%	96.065%	57.426%

Table 10 shows the aggregated values for each risk class resulting from the K/O calculation in Table 9. It contains the interim combined values of all criteria calculated to that point, in this case only Build and Driving Record – DUI/RD. The prevalence values in Table 10 are the sum of the Prevalence - combined in Table 9, for the risk class shown in Table 9 "Risk Class – combined" column. The RR Score is calculated similarly, but is a weighted average (using prevalence as the weight).

Table 10 K/O Combined results from data in Table 9 (for Build and Driving)

Risk Class	RR Score	Prevalence
Std	135.4%	17.026%
Pref	97.3%	25.548%
Pref+	90.7%	57.426%

Solely for the purpose of the example in this document, the values in Table 10 are used in the next step of the calculation assuming that this is the final impact table after all K/O risk criteria have been reflected.

5.4 Determine the RR Scores and prevalences of all individual criteria based on Debit-Credit (D/C)

The calculation for reflecting the impact of the D/C criteria is illustrated below. It is very similar to the K/O process. The example uses the same Build and Driving Record criteria as were shown for the K/O calculations. A preferred risk program would not use the both the K/O and D/C approaches for the same criterion. This is done here only to allow for a more direct comparison of the two types.

Table 11 is the D/C equivalent to the K/O Table 5, except that debit points are assigned to various BMI ranges.

Table 11   Build - Sample BMI D/C qualification structure

Values defined by user		Determined by calculator					
Debit-Credit Points	Maximum qualification value	Minimum BMI qualification	Maximum BMI qualification	Cumulative values from assumption table		Calculated range values	
				RR Score	Prev	RR Score	Prev
5	35	30.1	35.0	100.0%	100.002%	128.0%	11.903%
3	30	27.1	30.0	96.2%	88.099%	100.5%	26.595%
0	27	20.1	27.0	94.4%	61.504%	93.7%	59.778%
5	20	15.1	20.0	118.1%	1.726%	118.0%	1.724%
Program min	15.1	BMIs 15.0 and lower do not qualify as standard risks		227.6%	0.002%	-	-

The above tables indicate that individuals with BMIs between 30.1 – 35.0 and 15.1 – 20.0 will receive 5 points in the defined D/C structure. Those with BMIs in the range 27.1 – 30.0 have 3 points added to their score. BMIs between 20.1 and 27.0 receive 0 points.

The values in the columns "Debit-Credit Points" and "Inputted level maximum" are defined by the user in the criteria section. The values in the "Cumulative assumption table values" are obtained from the assumption table. The "Calculated range values" are calculated using the "Cumulative assumption table values". These calculations are exactly the same as the ones described for the K/O criteria in Section 5.2b

The range values of the two distinct ranges assigned to the same number of points (5 in this example) are aggregated as illustrated in Table 12 below.

Table 12   Combined ranges with the same number of points

Debit-Credit Points	Calculated range values	
	RR Score	Prevalence
Total 5	126.7%	13.627%
5	128.0%	11.903%
5	118.0%	1.724%

Table 13 shows the final D/C point impact for the Build criterion.

Table 13   Build impact on D/C point distribution

Debit-Credit Points	Calculated range values	
	RR Score	Prevalence
5	126.7%	13.627%
3	100.5%	26.595%
0	93.7%	59.778%

Table 14 shows the impact of the Driving Record – DUI and Reckless Driving. The first five columns on the left are input based on the program definition. The column "Cumulative assumption table values" are the assumption table values. The column "Calculated range values" are the range values calculated from the numbers in the Cumulative values. The "0" debit-credit points do not need to be entered. The calculator assumes that the best mortality receives "0" points.

Table 14   Driving record (DUI and Reckless Driving) impact on D/C score

Values defined by user					Cumulative values from assumption table		Calculated range values	
Debit-Credit Points	Risk type	No. of years reviewed	No. of allowed events	Flat extras allowed	RR Score	Prev	RR Score	Prev
					100.0%	100.0%		
2	DR	10	0	Y	96.8%	96.065%	177.6%	3.935%
0							96.8%	96.065%

The contents of Table 15 are the values from Table 14 passed on to the next step of the calculation.

Table 15   Driving record (DUI and Reckless Driving) impact on D/C score

Debit-Credit Points	Calculated range values	
	RR Score	Prevalence
2	177.6%	3.935%
0	96.8%	96.065%

5.5 RR Score and prevalence aggregations of all D/C based criteria qualifications

Table 16 shows the calculation which combines the impacts of Build (table 13) and Driving Record (table 15) when D/C qualification criteria are used. The D/C calculations are equivalent to the K/O calculations described in Table 9, with one exception. The values in the "D/C Points – Combined" column are the sum of the values in the "D/C Points – Build" and "D/C Points – Driving columns". This is the only difference in the D/C and K/O logic.

Table 16 Combining the D/C results from tables 13 and 15

D/C Points			RR Score			Prevalence		
Build	**Driving**	**Combined**	**Build**	**Driving**	**Combined**	**Build**	**Driving**	**Combined**
5	2	7	126.7%	177.6%	225.1%	13.627%	3.935%	0.536%
5	0	5	126.7%	96.8%	122.7%	13.627%	96.065%	13.091%
3	2	5	100.5%	177.6%	178.6%	26.595%	3.935%	1.047%
3	0	3	100.5%	96.8%	97.3%	26.595%	96.065%	25.548%
0	2	2	93.7%	177.6%	166.4%	59.778%	3.935%	2.352%
0	0	0	93.7%	96.8%	90.7%	59.778%	96.065%	57.426%

Table 17 groups the values from Table 16. The prevalence values in table 17 are the sum of the "Prevalence – combined" in Table 16, based on the D/C point values shown in the "D/C Points – Combined" column in Table 16. The RR Score values are calculated similarly, but on a weighted average (using "Prevalence – Combined" as the weight).

Table 17 D/C grouped results from Table 16

D/C Points	RR Score	Prevalence
7	225.1%	0.536%
5	126.8%	14.137%
3	97.3%	25.548%
2	166.4%	2.352%
0	90.7%	57.426%

The impacts of all remaining D/C risk criteria are added using this same approach, one criterion at a time. The final overall results for the debit-credit criteria would look like Table 17. It would provide the RR Scores and prevalences of all possible combinations of D/C Points. It is likely that the final table would have a much larger set of D/C points than those shown in Table 17 above.

The order of adding the impacts of the individual risk criteria does not alter the final D/C result.

Solely for the purpose of the example in this document, the values in Table 17 are used in the next step of the calculation assuming that this is the final impact table after all D/C risk criteria have been reflected.

5.6 Converting D/C Points into Risk Class

Once the D/C impact of all criteria have been combined, the final point distribution needs to be converted into a risk class structure. The conversion is defined by the specific debit-credit portion of the program, as defined in the structure details.

Table 18 is an example of how a D/C program could be defined. It indicates the number of debit points which would qualify the risk for a particular risk class. The actual values are manual inputs provided by the user in the structure details.

Table 18 Defining the qualifications of a D/C Program

	No. of D/C Qualifying Points	
Risk Class	*Minimum*	*Maximum*
Std	5	7
Pref	2	4
Pref+	0	1

Values defined by user heads the two right columns above (No. of D/C Qualifying Points).

Table 19 shows how the D/C points are mapped into a particular risk class. The values in the first three columns come from Table 17. The "Risk Class" column shows the D/C point mapping into a risk class based on the values shown in Table 18.

Table 19 Mapping Risk Class to a D/C point distribution

D/C Points	*RR Score*	*Prevalence*	*Risk Class*
7	225.1%	0.536%	Std
5	126.8%	14.137%	Std
3	97.3%	25.548%	Pref
2	166.4%	2.352%	Pref
0	90.7%	57.426%	Pref+

Table 20 is the final risk class impact of all criteria using the D/C qualification logic. It is the result of grouping the values for each risk class from table 19.

Table 20 Risk Class qualifications of D/C point structure

Risk Class	*RR Score*	*Prevalence*
Std	130.4%	14.674%
Pref	103.2%	27.901%
Pref+	90.7%	57.426%

5.7 Combining the RR Scores and prevalences of the final K/O and D/C criteria

Up to this point in the calculation process, the calculations for K/O and D/C logic have been kept completely separate. However, it is possible for a program to include both K/O and D/C qualification restrictions. Programs can have some criteria qualifications using the K/O logic, (the risk qualifies for only the worst risk class across all K/O criteria), and others using D/C logic. The calculator accommodates this combination type of qualification logic.

The impacts of the K/O based qualification criteria and the D/C qualification criteria have already been described in earlier sections. Tables 10 and 20 show the final example results of each set.

Tables 10 and 20 are used for expedience. The calculations for both the K/O and D/C criteria both used the same criteria, build and Driving Record - violations. This was done to allow for a comparison of the methods for each of the two types of logic. In a real life case, any one criterion will use only one of the two types of logic, either the K/O or D/C. Using both sets of logic for a single specific criterion is not possible.

The logic shown in Table 21 is exactly the same as that used in combining the results of the individual K/O criteria, as shown in Table 9.

Table 21   Combine impacts of K/O and D/C risk class qualifications

Risk Class			RR Score			Prevalence		
K/O(Tab 10)	D/C(Tab 20)	Combined	K/O	D/C	Combined	K/O	D/C	Combined
Std	Std	Std	135.4%	130.4%	176.6%	17.026%	14.674%	2.498%
Std	Pref	Std	135.4%	103.2%	139.7%	17.026%	27.901%	4.750%
Std	Pref+	Std	135.4%	90.7%	122.8%	17.026%	57.426%	9.777%
Pref	Std	Std	97.3%	130.4%	127.0%	25.548%	14.674%	3.749%
Pref	Pref	Pref	97.3%	103.2%	100.4%	25.548%	27.901%	7.128%
Pref	Pref+	Pref	97.3%	90.7%	88.3%	25.548%	57.426%	14.671%
Pref+	Std	Std	90.7%	130.4%	118.3%	57.426%	14.674%	8.426%
Pref+	Pref	Pref	90.7%	103.2%	93.6%	57.426%	27.901%	16.022%
Pref+	Pref+	Pref+	90.7%	90.7%	82.2%	57.426%	57.426%	32.977%

Table 22 is the final set of values for each of the risk classes. It shows the results for each risk class, based on the values shown in Table 21. The values in the Prevalence column are the sum of the values in the "Prevalence – Combined" column in Table 21, for the risk class noted in the "Risk Class – Combined" column. The RR Score column is similarly calculated values using the values in the "RR Score – Combined columns, weighted by the "Prevalence – Combined" values.

Table 22   Age range specific combined RR Score & Prevalence values

Risk Class	RR Score	Prevalence
Std	129.4%	29.201%
Pref	92.8%	37.822%
Pref+	82.2%	32.977%

5.8 Normalize the prevalences

When the program minimum and maximum qualifying values for all criteria are equal to the industry standard values, the risk class prevalence sums and the RR Score weighted average of RR Score shown in Table 22 will be 100%. However, the calculations and assumption table values accommodate program minimum and maximum qualifying values which are not equal to the industry standards. The prevalences and RR Scores will likely not equal 100%, when the user inputs program minimum and/or maximum values defined by the user not equal to the industry standard. When this occurs, the prevalences are normalized back to 100%. The RR Scores are not normalized.

Therefore, liberal program minimums and maximums could point at higher RR tables. Conservative limits could result in the use of lower RR tables.

The following example assumes that a program has defined 40 as the maximum BMI it will accept as a standard risk. This is more lenient than the industry standard of 35. The assumption table indicate that this allows an extra 1.0% of policies to be accepted as a standard risk, and therefore qualifies for the preferred program. That 1.0% of the policies

has an average RR Score of 195.9%. Normally, all of this extra risk would end up in the standard risk class. These values come from the prevalence and RR Score assumptions for BMIs of 36 – 40 in the BMI section of the assumption table.

The actual impact on the program, by defining BMIs up to 40 as standard risks, would have already been automatically imbedded in the calculations already described. The net RR Score and prevalence impact would have been to increase the prevalence of the Std class to 30.20% (29.20% + 1.00%) and the RR Score to 131.63% (obtained by weighting 29.20% at 129.43% and 1.00% at 195.9%). The more liberal restriction has increased the total portfolio RR Score by almost 1% to 100.94%, as shown in Table 23 below.

Table 23   Impact of liberal program definition of standard risks

Risk Class	RR Score	Prevalence
Total	100.94%	101.000%
Std	131.57%	30.201%
Pref	92.80%	37.822%
Pref+	82.24%	32.977%

Based on these results the prevalences are now normalized back to 100%. The final RR Score results are shown in Table 24, with all prevalences normalized by dividing the prevalences in Table 23 by 1.01. The RR Scores left at their values, with an average RR Score of 100.97%. They are not adjusted back to 100%.

Table 24   Adjusted prevalence due to liberal program

Risk Class	RR Score	Prevalence
Total	100.94%	100.000%
Std	131.57%	29.902%
Pref	92.80%	37.447%
Pref+	82.24%	32.651%

5.9 Combine the RR Scores and prevalences across all defined age ranges

To this point, separate calculations (up to 6) are completed for each of the age ranges defined by the user. There will be between 1 and 3 age ranges for each of the Non-tobacco and Tobacco classes. This step combines the specified age ranges into a single overall set of values, one each for non-tobacco and tobacco. Since the final RR Tool provides separate RR Score values for the non-tobacco and tobacco categories, the values for the tobacco and non-tobacco categories are not combined.

The type of results shown in section 5.8 above would be calculated separately for each defined age range. In this step, they are weighted together. The weight is the relative expected claims of each of the age ranges (with separate expected claims calculated for males and females). The expected claims are determined by multiplying the appropriate mortality rates and face amounts for each age range. The mortality rate and face amount values used in the calculation are both stored in the assumptions table. Values are provided in 5-year age ranges. The stored mortality rate in each of these ranges is the duration five (5) mortality rate from the 2015 VBT RR100 table at the

central age of the specific 5 year age range. The stored face amount value for each of the five year ranges is the total exposure face amount included in the SOA 2008-09 experience study for policies with face amounts of $100,000 and larger in durations 1 – 3.

The following is an example of how two age ranges are defined for the program. It assumes that the first age range is for ages 18 – 29. The second is for ages 30 – 39. These age ranges are for calculation illustration only to simplify the calculation. Normally, a program would have a much wider set of age ranges. A non-smoker calculation is shown below. The smoker calculation has its own calculation using an equivalent set of smoker values.

Table 25   Weighting results from multiple age ranges

	Portfolio age range 1		Portfolio age range 2	
Issue age	18-24	25-29	30-34	35-39
Mortality rates				
Male NS	0.47	0.25	0.30	0.46
Female NS	0.22	0.18	0.24	0.42
Face Amount Exposures (mm)				
Male NS	38.0	149.1	313.1	400.7
Female NS	38.4	121.8	197.3	200.2
Expected Claims (mm)				
Male NS	17.86	37.28	93.93	184.32
Female NS	8.45	21.92	47.35	84.09
Total expected claims	26.31	59.20	141.28	268.41
Portfolio age range weight				
Total expected claims	85.51		409.69	
% of total	17.3% (= 85.51 / (85.51 +409.69))		82.7%	

In this example, 17.3% of the values would come from the portfolio age range 1 (18 – 29) calculation and 82.7% from the portfolio age range 2 (30-39) results. The result of this calculation is the final RR Score. A final score of 74.4 would be produced, if the RR Score for a particular risk class for age range 1 was 70, and 75 for age range 2. The value 74.4 is calculated using the formula (74.4 = 70 * .173 + 75 *.827).

6   Validation of the Results

Validation of the results is very difficult. No actual experience was available to the committee at this time. Additionally, the results were not compared to those coming from the prior calculator with the new one. Since the methods are very different, any comparisons would not be consistent across portfolios. Also, the prior results were not based on any experience data.

To-date, the industry has not collected the information necessary to attach RR Scores to their preferred risk portfolios for experience study purposes. It is recommended that the necessary information be added to experience study data, and then included in the insurer's experience, to allow for an analysis of the validity of the RR Score.

In the interim, the best that can be done is to evaluate the reasonableness of the results with overall recent industry experience. Two approaches were used for this.

The first approach was to create a fairly aggressive, but plausible, set of risk class criteria to evaluate the reasonableness of its calculated RR Score. This criterion set is shown in Table 26 below. For this best preferred class definition, the scoring system produces an RR Score of 69.4. A score of 69 is a reasonable score for a fairly aggressive set of criteria when compared to the average best preferred class experience of 78.8% and 75.6% in the three and four class structures, as shown in Table 27.

Table 26 Sample set of strict preferred criteria

Criterion	Preferred standard
Blood Pressure	120/80 No qualification difference if being treated for BP
BMI	27
Cholesterol Ratio	5.0 No qualification difference if being treated for Cholesterol
Driving Record	Moving violations: No more than 2 in last 3 years, flat extras not allowed DUI/RD: No violations in the last 10 years, flat extras not allowed
Family Hx	All four diseases included Either death or disease Applies to parents or siblings No incidents allowed All incidents before age 60 considered No additional conditions
Personal History	All five diseases considered, No history of disease definition No additional conditions
Substance Abuse (both alcohol and drug)	None in 20 years
Other factors	Five other factors used (all but residency) No additional restrictions

The second approach was to compare recent preferred experience to plausible preferred risk structures. The preferred risk results from the most recent Society of Actuaries individual life experience study were used as the experience against which the RR Scores were compared. The experience values in Table 27 are the results shown in Appendix M p. 2 of the 2008-2009 Society of Actuaries experience study.

The values shown are the non-smoker relative mortality of each risk class to the mortality of all risk classes combined. These relative experience ratios have the same conceptual principles underlying the calculation of the RR Score. However, the two methods use very different, and independent, approaches. The experience shown is the actual average relative industry mortality among the risk classes. The calculator determines the same relative mortality for each risk class using the logic and assumptions underlying the RR Tool.

Since all 3 and 4 class structure experience is fairly recent, there will be little preferred wear-off in the all duration results. Those values were used to compare to the calculated RR Scores. The 3 NT class system industry average relative experience ratios are 79% for the best preferred class, 89% for the middle class and 125% for the standard class. In a four class system, the average relative experience ratios are 76%, 98%, 114% and 135% from best to

worst risk class, respectively. Table 27 also includes the experience for only durations 1 – 5, and 6 – 10. These would also be appropriate, but likely not as smooth since they contain less experience.

Table 27   SOA 2008-09 Individual Life Experience Committee (ILEC) study relative mortality by risk class - Appendix M p.2

| No. of risk classes | Risk class number | Relative mortality – all ages | | |
		Durations 1 – 5	Durations 6 - 10	All durations
3	1	79.1%	78.3%	78.8%
	2	89.1%	96.2%	92.6%
	3	124.8%	128.8%	126.3%
	Total	100.0%	100.0%	100.0%
4	1	72.1%	86.2%	75.6%
	2	100.2%	94.1%	98.2%
	3	118.5%	99.9%	113.7%
	4	131.5%	148.0%	135.4%
	Total	100.0%	100.0%	100.0%

This experience was then compared to the RR Scores calculated from two reasonable criteria sets, one 3 class and one 4 class structure, both knock-out. Other risk class criteria could be used and would result in different RR Scores. There is no single unique set of results which are the most correct values. No comparable debit-credit comparison was done because current experience represents recent programs, most of which are of the knock-out variety.

Table 28 shows the criteria used for the sample three class system. The results are shown in Table 29.

Table 28 Three NT risk class structure definition

Criterion	Risk class qualification		
	Preferred +	Preferred	Standard
Blood Pressure	<=130/85 No diff for treated	<= 135/90 No diff for treated	<=145/95 No diff for treated
BMI	Male <=28.5 Female <= 25.8	Male <= 30.9 Female <=27.8	Male <= 35.0 Female <= 35.0
Cholesterol Ratio	<= 5.0 No diff for treated	<= 6.0 No diff for treated	<= 9.0 No diff for treated
Total Cholesterol	<= 230 No diff for treated	<= 250 No diff for treated	<= 275 No diff for treated
Driving Record	• MV: No more than 2 in last 3 years, flat extras allowed • DUI/RD: Both considered, none allowed in last 5 years, flat extras allowed	• MV: No more than 3 in last 3 years, flat extras allowed • DUI/RD: Both considered, none allowed in last 5 years, flat extras allowed	No restricting criteria
Family Hx	• All four diseases included • Either death or disease • Applies to parents or siblings • No incidents allowed • All incidents before age 60 considered • No extra disease restrictions added	• All four diseases included • Death only • Applies to parents or siblings • No incidents allowed • All incidents before age 60 considered • No extra disease restrictions added	No restricting criteria (should be none, since Family History is not a common std / substd consideration)
Personal History	• All five diseases considered • Definition: No history of disease	• All five diseases considered • Definition: No history of disease	No restricting criteria
Substance Abuse (both alcohol and drug)	• None in 10 years	• None in 10 years	No restricting criteria (i.e. – normal industry std is used for std/substd underwriting
Other factors	No restricting criteria	No restricting criteria	No restricting criteria

Table 29 Three NT risk class score results and comparison

Risk Class	RR Score	ILEC experience
Preferred +	78.3	78.8%
Preferred	98.1	92.6%
Standard	131.7	126.3%

Table 30 shows the criteria used for the sample four class system. The results are shown in Table 31.

Table 30 Four NT risk class structure definition

Criterion	Risk class qualification			
	Preferred ++	**Preferred +**	**Preferred**	**Standard**
Blood Pressure	<=125/80 No diff for treated	<= 140/85 No diff for treated	<=145/90 No diff for treated	<=145/95 No diff for treated
BMI	{> 15.0 and <= 27.0}	{> 27.0 and <= 31.0}	{> 31.0 and <= 33.0}	{> 33.0 and <= 35.0}
Cholesterol Ratio	<= 6.0 No diff for treated	{>6.0 and <= 7.0} No diff for treated	{> 7.0 and <= 8.0} No diff for treated	{>8.0 and <= 9.0} No diff for treated
Total Cholesterol	{>130 and <= 210} No diff for treated	{> 210 and <= 250} No diff for treated	{> 250 and <= 275} No diff for treated	{> 275 and <= 290} No diff for treated
Driving record	• MV: No more than 2 in last 3 years, flat extras allowed • DUI/RD: Both considered, none allowed in last 10 years, flat extras allowed	• MV: No more than 2 in last 3 years, flat extras allowed • DUI/RD: Both considered, none allowed in last 6 years, flat extras allowed	No restricting criteria	No restricting criteria
Family Hx	• All four diseases included • Either death or disease • Applies to parents or siblings • No incidents allowed • All incidents before age 60 considered	• All four diseases included • Death only • Applies to parents only • No incidents allowed • All incidents before age 60 considered	• All four diseases included • Death only • Applies to parents only • No incidents allowed • All incidents before age 60 considered	No restricting criteria (should be none, since Family History is not a common std/substd consideration)

Criterion	Risk class qualification			
	Preferred ++	**Preferred +**	**Preferred**	**Standard**
	• No extra diseases added	• No extra diseases added	• No extra diseases added • No extra diseases added	
Personal History	• All five diseases considered • Definition: No history of disease • No extra diseases considered	• All five diseases considered • Definition: No history of disease • No extra diseases considered	• All five diseases considered • Definition: No ratable disease • No extra diseases considered	No restricting criteria
Substance abuse (both alcohol and drug)	• None in 10 years	• None in 10 years	• None in 10 years	No restricting criteria (i.e. – normal industry std is used for std/substd underwriting
Other factors	• Aviation restriction	• Aviation restriction	No restricting criteria	No restricting criteria

Table 31 Four risk class score results and comparison

Risk Class	RR Score	ILEC experience
Preferred ++	72.7	75.6%
Preferred +	94.3	98.2%
Preferred	126.8	113.7%
Standard	161.9	135.4%

7   Definition restrictions

The RR Tool allows significant flexibility in defining the risk class qualifications. It is logical that the qualifications become more restrictive for the lower mortality risk classes. The formulas in the calculator rely on this progression. The calculator will not produce accurate results if this logical progression is not followed. This is particularly important for criteria with multiple components in the restriction.

For example, the family history restriction has four components: event definition, family relationship, maximum number of allowed events and the maximum age of the family member. The options of each of these components recognized in the assumption tables is provided below, in order of least to most restrictive.

Event definition: Death, death or diagnosis
Family relationship: Parents, parents or siblings, parents, siblings or other close relations
Maximum number of allowed events: 2, 1, 0
Max age of family member: 50, 55, 60, 65, 70

For the calculations to work properly, all definitions used for a more restrictive risk class must be no less restrictive than what is used in any less restrictive risk class. The calculation results will not be appropriate if a more restrictive "pref+" risk class allows 2 events and a less restrictive "pref" risk class allows only 1 event. This will be the case, even if other components of the definition are more restrictive.

8   Members of the Underwriting Criteria Team

Member	*Discipline*
Dieter Gaubatz (chair)	Actuary
Jaron Arboleda	MIB
Jean-Marc Fix	Actuary
Kim Genik	Underwriter
Anna Hart	Underwriter
Carl Holowaty	Medical Director
Doug Ingle	Underwriter
Al Klein	Actuary
Peter Komsthoeft	Underwriter
Ev Kunzelman	Underwriter
Kevin Larsen	Actuary
Jack Luff	Actuary / SOA
Cynthia MacDonald	Actuary / SOA
Pete Miller	Actuary / SOA
Brad Roudebush	Actuary
David Winsemius	Medical Director
David Wylde	Actuary

In addition to the members of the UCT, we also need to thank Philip Adams (Actuary) and Suzanne Chapa (Actuary) who provided significant assistance with the creation of the assumptions. Lastly, our employers also need to be thanked to allow the committee members to expend the significant amount of effort required to complete this project.

11 Bibliography

1. Scheuner MT, Whitworth WC, McGruder H, Yoon PW, Khoury MJ. Expanding the definition of a positive family history for early-onset coronary heart disease. Genet Med. 2006 Aug;8(8):491-501.

2. Lloyd-Jones, Donald M. et al. Parental Cardiovascular Disease as Risk Factor for Cardiovascular Disease in Middle-aged Adults. JAMA 2004;291:2204-2211

3. Murabito, Joanne M. et al. Sibling Cardiovascular Disease as a Risk Factor for Cardiovascular Disease in Middle-aged Adults. JAMA 2005; 294:3117-3123

4. Nasir, Khurramm, et al. Family History of Premature Coronary Heart Disease and Coronary Calcification. Circulation 2007;116:619-626

5. Mainous AG III, Koopman RJ, Diaz VA, Everett CJ, Wilson PW, Tilley BC. A coronary heart disease risk score based on patient-reported information. Am J Cardiol. 2007 May 1;99(9):1236-41.

6. Seshadri S, Beiser A, Pikula A, Himali JJ, Kelly-Hayes M, Debette S, DeStefano AL, Romero JR, Kase CS, Wolf PA. Parental occurrence of stroke and risk of stroke in their children: the Framingham study. Circulation. 2010 Mar 23;121(11):1304-12.

7. Howlader N, Noone AM, Krapcho M, Neyman N, Aminou R, Waldron W, Altekruse SF, Kosary CL, Ruhl J, Tatalovich Z, Cho H, Mariotto A, Eisner MP, Lewis DR, Chen HS, Feuer EJ, Cronin KA (eds). SEER Cancer Statistics Review, 1975-2009 (Vintage 2009 Populations), National Cancer Institute. Bethesda, MD, http://seer.cancer.gov/csr/1975_2009_pops09/, based on November 2011 SEER data submission, posted to the SEER web site, April 2012.

8. Ramsey SD, Yoon P, Moonesinghe R, Khoury MJ. Population-based study of the prevalence of family history of cancer: implications for cancer screening and prevention. Genet Med. 2006 Sep;8(9):571-5.

9. Narayan KM, Boyle JP, Thompson TJ, Sorensen SW, Williamson DF. Lifetime risk for diabetes mellitus in the United States. JAMA. 2003 Oct 8;290(14):1884-90.

10. Rozar T, Rushing S. An Analysis of Motor Vehicle Records and All Cause Mortality. 2012. [Online]. Available: http://inside.rgare.com/ departments/marketing/Corporate%20Information%20Documents/ Rozar_Rushing_An_Analysis_of_Motor_Vehicle_Records_and_All_ Cause_Mortality_0312.pdf