Office of Pipeline Safety (OPS) Risk Ranking Index Model (RRIM) Documentation
2026 Run for Year 2027 Planning

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A. Overview

The Pipeline and Hazardous Materials Safety Administration (PHMSA) OPS places all hazardous liquid/carbon dioxide, gas transmission, and gas gathering pipelines regulated by OPS regions into Units. All in-service or idle Units are grouped into Inspection Systems, which may include one or many Units. PHMSA generates a risk score for each Unit; the Inspection System risk score is the sum of the Unit risk scores divided by a constant normalization factor.

Each Inspection System risk score falls into one of three risk tiers, each with a maximum Time Since Last Inspection (TSLI). The TSLI for each Inspection System is determined based on previous inspections, and the "Inspection System Remaining TSLI" is calculated by subtracting the Inspection System TSLI from the risk tier maximum TSLI value.

RRIM results present Inspection Systems with the lowest "Inspection System Remaining TSLI" as the highest priority for inspection.

B. Data Sources

Data Source	System of Record	Data
Unit	Work Management System (WMS)	Unit ID, operator ID, pipeline type (hazardous liquid/carbon dioxide, gas transmission, or gas gathering), lead regulator, commodity, mileage, miles of pre-1970 low frequency electric resistance welded (ERW) pipe, miles of bare pipe, ineffective external coating indicator, and number of components in the unit. Components are breakout tanks, compressor stations, and pump stations.
Inspection System	WMS	Inspection system ID, system type (hazardous liquid or gas), and lead regulator.
National Pipeline Mapping System (NPMS)	NPMS	NPMS contains segmented geographic information system data for hazardous liquid/carbon dioxide and gas transmission pipelines. The number of segments for a unit range from a few to several hundred. NPMS segments are collapsed based on diameter, high consequence area (HCA) type, State, onshore/offshore, and unit ID.
Significant Incidents	Online Data Entry System 2.0	Each significant incident on a pipeline regulated by an OPS region is manually assigned to a Unit.
Enforcement	WMS	Type, operator ID, inspection activity preceding enforcement, and date inspection started.
National Registry Notifications	Operator Management System (OMS)	Type, operator ID, and submittal date.
Activities	SMART Inspection for 2019 and prior; WMS for 2020 and later	Activity type, inspection dates, effort, unit ID, and operator ID.

C. Threat Factors

1. Mileage
Weight: (0 – 3)

Use the NPMS to determine unit mileage. If miles are missing in NPMS, use WMS unit component miles. Add facility proxy miles to calculate total unit miles:

HL Breakout Tank	HL Pump Station	Gas Compressor Station
6.6	20.2	36.8

Weight is determined per the table below.

Unit Miles (including facility proxy miles)	Weight
Unit Miles < (Max Unit Miles – Min Unit Miles)/18	0
(Max Unit Miles – Min Unit Miles)/18 **< Unit Miles <** (Max Unit Miles – Min Unit Miles)/6	0.5
(Max Unit Miles – Min Unit Miles)/6 **< Unit Miles <** (Max Unit Miles – Min Unit Miles)/2	1
(Max Unit Miles – Min Unit Miles)/2 **< Unit Miles <** (Max Unit Miles – Min Unit Miles)*5/6	2
(Max Unit Miles – Min Unit Miles)*5/6 **< Unit Miles**	3

2. ERW Mileage
Weight (0 – 3)

ERW Miles are the number of miles in the unit that are steel pipe and were manufactured before 1970 by the low frequency ERW process.

Weight is determined per the table below.

ERW Miles	Weight
ERW Miles < (Max ERW Miles – Min ERW Miles)/18	0
(Max ERW Miles – Min ERW Miles)/18 **< ERW Miles <** (Max ERW Miles – Min ERW Miles)/6	0.5
(Max ERW Miles – Min ERW Miles)/6 **< ERW Miles <** (Max ERW Miles – Min ERW Miles)/2	1
(Max ERW Miles – Min ERW Miles)/2 **< ERW Miles <** (Max ERW Miles – Min ERW Miles)*5/6	2
(Max ERW Miles – Min ERW Miles)*5/6 **< ERW Miles**	3

3. Enforcement
Weight (0 – 3)

The enforcement weight value is a function of enforcement actions from I01, I02, I03, and I09 inspections from SMART activities and Integrated, Construction and Failure Investigations from WMS activities within the past seven years. Use "date inspection started" from enforcement data to determine time period.

The enforcement weight value is the highest single applicable value from the table below.

Enforcement Type	Time Period	Weight
Corrective Action Order (CAO) or Notice of Proposed Safety Order (NOPSO)	past three years	1.5
Corrective Action Order (CAO) or Notice of Proposed Safety Order (NOPSO)	four to seven years ago	3
Notice of Probable Violation (NOPV)	past three years	1
Notice of Probable Violation (NOPV)	four to seven years ago	2
Warning Letter (WL) or Notice of Amendment (NOA)	past three years	0.5
Warning Letter (WL) or Notice of Amendment (NOA)	four to seven years ago	1

4. National Registry Notification
Weight (0 – 0.3)

National Registry Notifications are submitted by the operator associated to the unit within the past year. Appendix 4 describes how notifications are associated to units. The National Registry Notification weight is the highest single applicable value from the table below.

Notification Type	Weight
Construction (Type F)	0.2
Operatorship Change/Acquisitions/Divestitures (Types B or D)	0.3

5. Commodity
Weight (1 – 6)

If the Unit has multiple commodity values in WMS, use the single highest applicable weight below. If the Unit has no commodity value, use "Gas (includes Hydrogen)" for gas Units and "Products" for liquid Units.

Commodity	Weight
Crude	6
Products	6
Gas (includes Hydrogen)	3
HVL, LPG, NGL	3
CO2	1
Anhydrous Ammonia	3

6. Bare Pipe
Weight (0 – 0.2)

To determine the weight, calculate the percentage of Unit miles that are steel and lack an external coating.

Percent	Weight
0%	0
0 < % <= 10	0.05
% > 10	0.2

7. Ineffective Coating
Weight (0 – 0.2)

Weight is based on the value of the Unit's ineffective external coating indicator.

Ineffective External Coating	Weight
No	0
Yes	0.2

8. Significant Incidents
Weight (0 - 3)

This value is based on the five most recent years of significant incidents. Weight is determined based on a combination of incident year and incident count and is the single highest applicable value from the table below.

Time Period	Weight for Multiple Accidents	Weight for Single Accident
last 3 years	3	1
last 5 years	2	0.5

9. Land Movement
Weight (0 - 3)

Using All-Reported GG, GT, and HL incidents from 2002 forward with cause of Earth Movement or Heavy Rains/Floods with Mudslide selected.

Unit Proximity to Incident	Threat Factor
Within 5 miles of one or more incident	3
Within 5+ to 10 miles of one or more incident	2
Within 10+ to 20 miles of one or more incident	1
20+ miles from all incidents	0

D. Consequence Factor

NPMS is the primary source for Unit miles. If miles are missing in NPMS, use WMS Unit component miles.

For Units without NPMS diameter data, use national average from the operator's annual report.

If the Unit has multiple commodity values in WMS, use the commodity with the highest threat weight when calculating the consequence factor.

See Appendix 1 for details on calculating the consequence factor.

E. Unit Risk Score

Calculate the Unit's risk score by summing the nine threat weights and multiplying by the consequence factor.

F. Inspection System Risk Score

Calculate the IS risk score by summing the Unit risk score for all the Units in the IS and dividing by four.

G. Inspection System Tiers and Time Since Last Inspection

Assign each IS to a tier based on the IS risk score.

Inspection System Risk Score	Tier	Maximum Time Since Last Inspection
lowest 25%	Low	7 Years
middle 50%	Medium	5 Years
highest 25%	High	3 Years

Inspection System (IS) Time Since Last Inspection (TSLI)
"Year of last inspection" for an IS is the most recent AFO or Virtual start date of O10 (operator integrated inspection) or WMS Integrated Inspection within the past seven years for the inspection system. This includes future dates up to the end of the current year. "AFO or Virtual start date" for an Activity is defined as the earliest AFO or Virtual assignment start date or if there are no AFO or Virtual Assignments, the earliest non-AFO Assignment start date. If "Year of last inspection" is found from O10 or WMS Integrated Inspection data, stop. If not, use the most recent start year of any I01 (unit inspection), I05 (specialized inspection), I06 (major project), and I09 (integrated inspection) or WMS First Operating inspection with AFO or Virtual days within the past seven years for any Unit in the IS. This includes future dates up to the end of the current year. If no "Year of last inspection" is found during the I01, 5, 6, 9 check, look for WMS Construction inspections with an end date in the current year, including future dates up to the end of the current year. If found, set "Year of Last Inspection" to the current year. If no "Year of last inspection" is

found, assign a TSLI of 8.

Maximum Unit TSLI in IS

The maximum Unit TSLI among all Units in the IS. “Year of last inspection” for a unit is the most recent start year of a WMS Integrated Inspection or WMS First Operating inspection where the Unit has certain AFO Conduct Inspection effort records within the past nine years including future dates up to the end of the current year. For inspections during years before 2022, all AFO Conduct Inspection effort records are considered. For inspections during 2022 and forward, only AFO Conduct Inspection effort records for a single Unit are considered. If none are found, look for I01 (unit inspection), I05 (specialized inspection), I06 (major project), and I09 (integrated inspection) provided the activity has been away from office (AFO) days within the past nine years for the unit. If no “Year of last inspection” is found, look for a Construction Inspection with an end date in the current year, up to the end of the current year, and set “year of last inspection” to the current year if found. If no “Year of last inspection” is found, assign a TSLI of 9. “Year of last inspection” is subtracted from the planning year to calculate TSLI.

H. Inspection System Remaining Time Since Last Inspection

“Inspection System Remaining TSLI” value is calculated by subtracting the “Inspection System TSLI” from the Maximum TSLI value for the appropriate tier. Inspection systems with the lowest “Inspection System Remaining TSLI” value are the highest priority for inspection.

Appendix 1 Calculating the Consequence Factor

To calculate the consequence factor for each unit:

1. Calculate the consequence index for each **HCA type** as follows:
    a. For each commodity type and pipe diameter category, multiply the weight for that combination of commodity and diameter by the unit mileage for pipelines carrying that commodity and with that diameter.
    b. Total the results from 1a above for each diameter-commodity combination.
    c. Multiply the index for each HCA type calculated in 1b above by the HCA value weight for each HCA type.
    d. Add the results from 1c above over all HCA types.
2. Calculate the consequence index for **onshore and offshore non-HCA areas** as follows:
    a. For each commodity type and pipe diameter category, multiply the weight for that combination of commodity and diameter by the unit mileage for pipelines carrying that commodity and with that diameter.
    b. Total the results from 2a above for each diameter-commodity combination.
    c. Multiply the index for onshore and offshore non-HCA areas calculated in 2b above by the value weight for onshore and offshore non-HCA areas.
    d. Add the results from 2c above for onshore and offshore non-HCA areas.
3. Calculate the consequence factor for **facilities** (breakout tanks, pump stations, storage fields, and compressor stations) as follows:
    a. Multiply the facility impact weight by the number of each facility storing that commodity and the commodity factor.
    b. Add the results from 3a above for all facility types.
    c. Multiply the consequence factor calculated in 3b above by the value weight for onshore non-HCA areas and the facility proxy miles in section C1.
4. Add the sums for HCAs (1), non-HCAs (3), and facilities (3).
5. Divide step 4 by the sum of all HCA mileage, all non-HCA Miles, and all facility proxy miles. Next, divide by a normalization factor of 10 to calculate the Consequence Factor. Normalization adjusts the range of Consequence Factor over all Units to be similar to the range of scores for the sum of the threat indices. Increase the score to the next highest integer. If a value of zero is calculated, use 0.5 as the Consequence Factor Weight.

Equations for the RRIM consequence index

$$\boldsymbol{H}_{kr} = \sum_{j=1}^{3} \boldsymbol{w}_{ijk}\boldsymbol{m}_{jkr}$$

$$\boldsymbol{N}_{lr} = \sum_{j=1}^{3} \boldsymbol{x}_{ijl}\boldsymbol{n}_{jlr}$$

$$\boldsymbol{T}_{r} = \sum_{q=1}^{4} \boldsymbol{c}_{q}\boldsymbol{y}_{i}\ \boldsymbol{p}_{qr}$$

$$\boldsymbol{CI}_{r} = \left(\sum_{k=1}^{3} \boldsymbol{vh}_{k}\boldsymbol{H}_{kr} + \sum_{l=1}^{2} \boldsymbol{vn}_{l}\boldsymbol{N}_{lr} + \boldsymbol{vn}_{1}\ \boldsymbol{T}_{r} \right) \Big/ F_{r}$$

$\boldsymbol{H}_{kr}$ = HCA index for HCA type *k* in Unit *r*

$\boldsymbol{w}_{ijk}$ = relative impact weight for commodity *i* and diameter *j* for HCA type *k*

$\boldsymbol{m}_{jkr}$ = pipeline mileage in Unit *r* and diameter *j* intersecting HCA type *k*

$\boldsymbol{N}_{lr}$ = Non-HCA index for non-HCA area type *l* (onshore or offshore) in Unit *r*

$\boldsymbol{x}_{ijl}$ = relative impact weight for commodity *i* and diameter *j* for non-HCA area type *l* (onshore or offshore)

$\boldsymbol{n}_{jlr}$ = pipeline mileage in Unit *r* and diameter *j* intersecting non-HCA area type *l* (onshore or offshore)

$\boldsymbol{T}_{r}$ = Facility index for Unit *r*

$\boldsymbol{c}_{q}$ = facility proxy miles – see section C1 -for facility type *q*

$\boldsymbol{y}_{i}$ = relative facility impact weight for commodity *i*

$\boldsymbol{p}_{qr}$ =number of facilities of type *q* in unit *r*

$\boldsymbol{CI}_{r}$ = Consequence Factor Weight for Unit *r*

$\boldsymbol{vh}_{k}$ = value weight for HCA type *k*

$\boldsymbol{vn}_{l}$ = value weight for non-HCA area type *l*

$\boldsymbol{vn}_{1}$ = value weight for onshore non-HCA area

$$F_{r} = 10\left(\sum_{k=1}^{3}\sum_{j=1}^{3} \boldsymbol{m}_{jkr} + \sum_{l=1}^{2}\sum_{j=1}^{3} \boldsymbol{n}_{jlr} + \sum_{q=1}^{4} \boldsymbol{c}_{q}\,\boldsymbol{p}_{q} \right)$$

Weights for calculating the RRIM consequence index

Weights for Populated HCA (w_{ij1})		Pipe Diameter		
		Small (<8)	Medium (8-20)	Large (>20)
Commodity	***I / j***	**1**	**2**	**3**
Crude Oil	**1**	5	15	25
Refined Products	**2**	25	50	75
HVLs	**3**	100	125	150
Anhydrous Ammonia	**4**	75	85	100
CO2	**5**	3	10	25
Natural Gas/Hydrogen	**6**	20	35	50

Weights for Drinking Water HCA (w_{ij2})		Pipe Diameter		
		Small (<8)	Medium (8-20)	Large (>20)
Commodity	***i \ j***	**1**	**2**	**3**
Crude Oil	**1**	50	100	150
Refined Products	**2**	50	100	150
HVL, LPG, NGL	**3**	1	2	3
Anhydrous Ammonia	**4**	1	1	1
CO2	**5**	0	0	0
Natural Gas/Hydrogen	**6**	0	0	0

Weights for Ecological HCA (w_{ij3})		**Pipe Diameter**		
		Small (<8)	**Medium (8-20)**	**Large (>20)**
Commodity	***i \ j***	**1**	**2**	**3**
Crude Oil	**1**	50	107	150
Refined Products	**2**	36	71	107
HVLs	**3**	7	14	21
Anhydrous Ammonia	**4**	7	14	21
CO2	**5**	1	4	7
Natural Gas/Hydrogen	**6**	14	29	43

Weights for Onshore Non-HCA (x_{ij1})		**Pipe Diameter**		
		Small (<8)	**Medium (8-20)**	**Large (>20)**
Commodity	***i \ j***	**1**	**2**	**3**
Crude Oil	**1**	43	86	129
Refined Products	**2**	75	107	150
HVLs	**3**	75	86	96
Anhydrous Ammonia	**4**	21	43	64
CO2	**5**	2	6	11
Natural Gas/Hydrogen	**6**	21	54	86

Weights for Offshore non-HCA (x_{ij2})		**Pipe Diameter**		
		Small (<8)	**Medium (8-20)**	**Large (>20)**
Commodity	***i \ j***	**1**	**2**	**3**
Crude Oil	**1**	83	117	150
Refined Products	**2**	50	83	117
HVLs	**3**	NA	NA	NA
Anhydrous Ammonia	**4**	NA	NA	NA
CO2	**5**	NA	NA	NA
Natural Gas/Hydrogen	**6**	0	0	0

Weights for Facilities		
Commodity	***i***	**Relative Impact Weights (y_i)**
Crude Oil	**1**	45
Refined Products	**2**	55
HVLs	**3**	120
Anhydrous Ammonia	**4**	130
CO2	**5**	75
Natural Gas (Storage Fields)	**6**	90

Relative Value Weights for HCAs and non-HCAs		**Relative Weight**
HCA Types	***k***	Vh_k
Population	**1**	9
Drinking Water	**2**	6
Ecological	**3**	3
Non-HCA Areas	***l***	vn_l
Non-HCA (onshore)	**1**	1
Non-HCA (offshore liquid)	**2**	3
Non-HCA (offshore gas)	**2**	1

Appendix 2 Incident-to-Unit Association

The Pipeline Data Mart (PDM)-Pipeline incorporates two methods of associating incidents to units.

As part of the daily data load, an xls spreadsheet of incident and unit data is uploaded. Records in the xls can be changed or removed, and new records can be added. Once revisions are complete, the revised xls is sent to the PDM-P contractor for incorporation in the daily data load.

As part of the daily data load, failure investigation activity data is imported from the work management system (WMS). Accident Investigation Division staff associate an incident to a unit within the WMS failure investigation activity for incidents occurring on or after 12-14-2017.

If an incident is found in both the xls and the WMS, the unit value in the xls is used. Within the PDM-P, the unit conformed dimension for the incident provides the incident-to-unit association.

Appendix 3 Change Summary

New in 2026 for 2027 Inspection Planning:

Inspection planning will now be done on a fiscal year basis instead of a calendar year basis. Inspections planned based on the 2026 run will start being inspected on 10/1/2026.

New in 2025 for 2026 Inspection Planning:

Modified the Significant Incident threat factor logic to consider last 5 years rather than 4-5 years ago. Ensures multiple incidents in last 5 years always gets a higher value than a single incident.

New in 2024 for 2025 Inspection Planning:

RRIM Team recommended and Field Operations approved updates to the Unit Risk Score algorithm. Facility Proxy Miles were updated and simplified. Threat factor weights were increased for ERW Mileage and Incidents. Added a threat factor for Land Movement. Within the Consequence Index, Facilities weights were adjusted to give higher weights to products that vaporize upon release.

New in 2021 for 2022 Inspection Planning:

All Enforcement data has been migrated from SMART Enforcement into the WMS. All Enforcement data used in calculating risk are now pulled from the WMS exclusively.

New in 2020 for 2021 Inspection Planning:

Inspection planning will now be done on a calendar year basis instead of a fiscal year basis. This means that the RRIM run will be done in November now, with implementation planned for the following January.

Inspection activities are now being recorded in the Work Management System (WMS) instead of the legacy SMART system. For this reason, Time Since Last Inspection (TSLI) logic had to be updated to account for the new activity naming conventions within the WMS.

New in 2019 for FY 2020 Inspection Planning:

Instead of using the average of unit risk scores as the IS risk score, we are using the sum of unit risk scores divided by four. By summing the unit risk scores, we avoid artificially inflating the risk for single-unit IS. We divide the sum by four to return IS risk scores to values typically seen in previous years.

We changed the IS TSLI logic to look for an end date of I02 (construction inspection) only in the current year instead of current and previous. This change results reduces the elapsed time until a high "Inspection System Remaining TSLI" value is set for newly constructed IS.

New in 2018 for FY 2019 Inspection Planning:

SME evaluations using risk trade-off analyses revised weights for most factors in the RRIM threat index. Weights were revised for all factors except the commodity and enforcement factors. The revised weights have been subjected to statistical testing, which demonstrates them to be consistent with unit incident history. We also revised consequence weights based on HCA type, commodity, and diameter. The revised weights are between 0 and 150, while the previous weights were between 0 and 9. This required a change in the normalization factor applied to the consequence index. Changed the normalization factor from 1,000 to the sum of all HCA mileage, all non-HCA Miles, and all facility proxy miles multiplied by 10. For a full description of all revisions made in response to the SME evaluations, see the document named SME Risk Tradeoff Analysis of RRIM Risk Factor Weights for FY 2019 Planning.

Proxy miles for non-pipeline facilities (breakout tanks, pump stations, compressor stations, and storage fields) were recalculated using updated incident data. For the first time, facility proxy miles were assigned based on unit facility populations and differentiated by the unit's commodity. Incident history from recent years for facilities was compared to incident history for line pipe, and incident rates were established for each. Incident rates for facilities were calculated as incidents per facility population (e.g., incidents per pump or compressor station, incidents per tank). Incident rates per mile were used for line pipe. The ratio between facility failure rates and line pipe failure rates established the proxy miles based on "risk-equivalent" mileage for each facility. These facility proxy miles are used in both the threat and consequence calculations.

The 25% of IS with the highest risk scores are placed in the High tier. The 25% of IS with the lowest risk scores are placed in the Low tier. The remaining 50% of IS are placed in the Medium tier.

We noticed a large percentage of total units in the lowest weighted category for both the Miles and ERW Miles variables compared to the percentage of total units in the other categories. After examining the frequencies of miles and ERW miles across the categories, we developed a strategy to more evenly distribute units in the zero-weighted lowest category. We created a new lowest 1/18 category with a score of zero. The remainder of the category was assigned a weight of 0.5 for Miles and 0.1 for ERW Miles.New in 2017 for FY 2018 Inspection Planning:

RRIM transitioned from SAS/Excel into a Pipeline Data Mart (PDM) dashboard.

RRIM is fiscal year based beginning with FY 2018 planning year (2017 run).

Planning year: October 1st sets the inspection planning year, based on the pending new fiscal year. For example, the June 2017 run is for planning year *2018*. On October 1, 2017, the planning year will become *2019*.

IM SPR/OPID included in the system results table.

On/Offshore removed, replaced with Pipeline Type.

Special Permits info only column was dropped.

New in 2014 for 2015 Inspection Planning:

PHMSA began using the Risk Ranking Index Model (RRIM) as a pipeline inspection scheduling tool in 2011. The RRIM results were based solely on the risk score generated by the RRIM algorithm for the pipeline systems. Many pipeline systems with high risk scores were either undergoing inspection or had been inspected the prior year. However, PHMSA pipeline Regions had to review inspection data to determine the Time Since Last Inspection (TSLI). In late 2014, PHMSA modified RRIM by assigning pipeline Inspection System (IS) risk scores into three tiers – High, Medium, and Low – and using inspection data to determine TSLI for each IS. Rather than forcing Regions to review inspection data to decide if it made sense to inspect the IS with the highest risk scores, TSLI was embedded in the results. IS risk score was no longer the actionable measure in the RRIM results.

PHMSA's leadership established maximum inspection intervals for each IS tier – three years for High, five years for Medium, and seven years for Low. PHMSA leadership determined that inspecting IS more frequently than once every three years did not allow sufficient time for pipeline operators to incorporate lessons learned into their safety programs. PHMSA selected three years as the maximum inspection interval for the High tier. We also discussed the positive safety impact achieved by simply scheduling an inspection with a pipeline operator. PHMSA decided that 7 years should be the maximum inspection interval for any IS, regardless of risk score. The actionable measure from the RRIM results became "Inspection System Remaining TSLI," defined as inspection system TSLI minus maximum TSLI from the appropriate tier.

PHMSA leadership's decision on maximum inspection interval per tier was made in conjunction with establishing risk score boundaries. The decision to inspect high risk IS once every three years is dependent on having 25% of the IS in any given year in the high tier. If "hard" risk scores were selected as boundaries, the number of IS in each tier could change each year and create abnormally high or low inspection workloads. The boundaries of risk tiers were selected to distribute approximately 25%/50%/25% in the high/medium/low tiers.

Added Notification Threat factor.

Appendix 4 Associating National Registry Notifications to Units

Below is the logic for each of the Notification Types –

1. Initial criteria match for **ALL** notification types -
    - Consider only notifications with Notification STATUS IN ('Processed', 'Submitted', 'In progress')
    - Compare the Notification OPID to the OPID from Operator – Unit History
2. In addition to the above criteria, each notification type has its own additional criteria –

Type B –

1. Using the EFFECTIVE_DATE to check if it falls within the Unit transaction dates in operator unit history (Move)
2. We check Unit's system type is within ('GD', 'GT', 'GG', 'HL', 'LNG') but we don't compare Notification system type to match with the unit's system type

Type D

1. Using the EFFECTIVE_DATE to check if it falls within the Unit transaction dates in operator unit history (Move)
2. We check Unit's system type is within ('GD', 'GT', 'GG', 'HL') but we don't compare Notification system type to match with the unit's system type
3. Compare Unit State and County with Notification State and County and if no match found, check if the Notification State is part of Offshore states in ('OCSAL', 'OCSAT', 'OCSG','OCSP')

TYPE F

1. Using the NOTIF_DATE to check if it falls within the Unit transaction dates in operator unit history (Move)
2. We check Unit's system type is within ('GD', 'GT', 'GG', 'HL') but we don't compare Notification system type to match with the unit's system type
3. Compare Unit State and County with Notification State and County and if no match found, check if the Notification State is part of Offshore states in ('OCSAL', 'OCSAT', 'OCSG','OCSP')

Appendix 5 Basis for the Model and Selection of Factors

PHMSA assigns each federally regulated gas gathering, gas transmission (GT), and hazardous liquid (HL) pipeline facility to an inspection unit. Since RRIM calculates a risk score for each unit, all data used in RRIM must be available at the unit level; this limits the data sources that can be used.

When PHMSA created RRIM in 2011, we examined standard risk-assessment techniques used by both industry and institutes of higher education to determine what broad risk analysis approach would best suit our data limitations and challenges. PHMSA considered several different potential approaches for the RRIM algorithm, including probabilistic risk assessment, fault trees, failure modes and effects analysis (FMEA), and risk index models that are used widely in the pipeline industry. One example of a pipeline industry risk index model is the approach presented in the book *Pipeline Risk Management Manual* by W.K. Muhlbauer, which was published in 2004. Pipeline operators have successfully used this approach to prioritize a large number of items or activities by relative risk (e.g. pipeline segments that require integrity assessments).

PHMSA determined that a combination of FMEA and risk-index modeling would be the best fit for unit-level data. Methods requiring an actual estimate of absolute risk using standard measures such as probabilities or expected costs is not feasible given the data available to PHMSA at the unit level. Although these methods may be feasibly applied by operators to support risk-based decision making, the limited amount of detailed data on risk factors on pipeline units available to PHMSA prevents use of these methods for inspection planning. Additionally, the infrequent nature of pipeline failures leads to a limited pool of data and, therefore, precludes a model that could predict failures.

The RRIM risk score for each unit is calculated as the product of a threat index score and a consequence index score. These index scores are based on values and weights for risk factors that affect the relative frequency and consequences of failures. When PHMSA created RRIM in 2011, our SMEs identified unit-level data that could be used for inspection prioritization. SMEs determined whether the variables were appropriate for threat or consequence calculations, and developed numerical weights to represent the risk significance of each factor. The factors are recognized as indicative of increased risk based on past research, experience, or data analysis.

Mileage Threat Factor

Each mile of pipeline is exposed to integrity threats that can lead to failure; however, different pipeline segments are exposed to threats of varying intensity. Individual segments have unique characteristics and operating conditions that result in disparate resistance to threats, distinct levels of threat mitigation, and divergent failure frequency. However, all else being equal, the more miles of pipeline, the higher the expected frequency of failure. Consequently, mileage has served as the basic exposure metric for the threat index since RRIM began in 2011. The numeric weight for mileage in the threat index is a step function approximation of a linear function with each mile receiving proportionally more weight.

In 2016, PHMSA enhanced the mileage threat factor by including proxy mileage value for facilities - breakout tanks, storage fields, pump stations, and compressor stations. This enhancement recognizes the increased risk that facilities pose and is particularly important for facility-only units that do not include pipeline miles.

Electric Resistance Welded (ERW) Mileage Threat Factor

ERW miles are the number of steel pipe miles in a unit that were manufactured prior to 1970 by the low-frequency ERW process. Pipe with an ERW seam has long been known to be at heightened risk for pipe failures due to an increased susceptibility to threats like cyclic fatigue, as well as certain types of corrosion. The National Transportation Safety Board (NTSB) cited ERW-seam pipe as a risk factor in Safety Recommendation P-87-026 (May 1988). Additionally, the Research and Special Programs Administration (RSPA)—the predecessor to PHMSA—issued alert notices to warn the pipeline industry of problems with ERW-seam pipe in January 1988 and March 1989. A 1989 RSPA study, "Electric Resistance Weld Pipe Failures on Hazardous Liquid and Gas Transmission Pipelines," Technical Report OPS 89-1, reemphasized the information in these alert notices. On June 7, 1994, the RSPA published a final rule, 59 FR 29370, that addressed pressure testing for older HL and carbon dioxide pipelines and stated that pressure testing is an effective means of identifying problems with ERW seams. Since we began RRIM in 2011, ERW miles has been used as a threat factor.

Enforcement Threat Factor

Enforcement actions are a tool that PHMSA uses to address deficiencies that violate regulations and require corrective action. Although specific violations are corrected by the operator following PHMSA's involvement, a PHMSA enforcement action serves as an indication that heightened scrutiny is warranted. For this reason, enforcement actions have been included as a threat factor since RRIM began in 2011. The numerical weights assigned for this factor are tied to the type of enforcement, with the types for more serious violations assigned higher weights.

National Registry Notification Threat Factor

Change creates uncertainty and increases threats to pipeline infrastructure and company operations. New construction, for example, can disrupt existing pipeline operations and present management challenges during the process of change. Additionally, mergers and acquisitions often involve a period of disruption as personnel are transferred and new procedures are adopted. PHMSA's construction, merger, and acquisition notifications are indicators of changes to operator-run infrastructure. In 2014, PHMSA added the notification threat factor to the RRIM model.

Commodity Threat Factor

PHMSA included the commodity as a threat factor because pipeline failure data shows that pipeline facility failure rates vary based on the commodities transported. The numerical weights for each commodity were based on its historical relative frequency of pipeline failures, as calculated using data from 2004 through 2009. At the time the weights were derived, there were only a few years of data collected using the revised 2010 incident/accident forms and reporting criteria; due to this, PHMSA confined the data to years before 2010, thereby allowing for the use of a consistent data set over a longer period. Because reporting criteria differ for HL and GT pipelines, the incidents/accidents included in the analysis are limited to incidents that meet GT reporting criteria, which are more restrictive. Accidents on HL lines that only met the release volume reporting criteria were not included in this data; however, HL incidents that met any other criteria (accident cost, fatality, injury, etc.) were included. This treatment allowed for the more consistent comparison of incident/accident frequencies between HL and GT pipelines. In an attempt to reduce the bias created by the change of costs over time, PHMSA also limited data to significant incidents. The relative commodity weights have been a factor since RRIM began in 2011.

Bare Pipe and Ineffective Coating Threat Factors

Bare pipe and ineffective coating are long-known risk factors that have the potential to impact pipeline integrity by increasing the likelihood of corrosion. Many existing PHMSA regulations recognize that bare and ineffectively coated pipes are at an increased risk; additionally, the NTSB cited ineffective coating as a risk factor in Safety Recommendation P-87-026, dated May 1988. These factors have been used since RRIM began in 2011.

Significant Incident Threat Factor

Pipeline incidents and accidents can occur when system failures impact either a pipeline facility or the systems used to monitor and protect the pipeline; additionally, pipelines and operators that experienced previous incidents have an elevated frequency of incidents moving forward. This effect diminishes over time, so that after a few years the incident frequency returns to near-average levels. PHMSA has also observed that multiple incidents or accidents in the same unit may be representative of inadequate post-incident corrective actions that then lead to a further elevation of the failure rate in subsequent years. To account for this, PHMSA bases the significant incident weight on a combination of time since incident and incident count. This threat factor has been used since RRIM began in 2011.

Consequence Index

PHMSA used the elements of a consequence model outlined in the book *Pipeline Risk Assessment: The Definitive Approach and its Role in Risk Management* by W.K. Muhlbauer, which was published in 2004 to define the factors included in the RRIM consequence index, which has been used since RRIM began in 2011. The consequence index factors related to the potential impact of pipeline facility failures are hazard, release volume, exposure, and receptors. Hazard is represented by the commodity transported. Release volume is represented by the pipeline diameter range of the pipeline. Exposure is represented by the miles of pipe and facility equivalent mileage. Receptors are represented by high consequence areas (HCA), non-HCA onshore areas, and offshore areas. The consequence index differentiates between the potential impacts to various HCA subtypes, including populated areas, drinking water sources, and ecologically sensitive areas. The weights for combinations of factors were derived from SME evaluation of the relative severity of impacts.

OIG Audit ST2023032, PHMSA Established an Effective Integrated Inspections Program but Needs To Strengthen Guidelines To Mitigate Risks, May 31, 2023

The audit report included a recommendation to explain how pipeline age and manufacturer, volume transported, pressure, seismicity, climate, geology, and demography should or should not be considered as part of RRIM. These factors are included in 49 U.S.C. § 60108(b)(1).

During the audit, PHMSA consistently maintained that 49 U.S.C. § 60108(b)(1) lists factors that must be addressed by PHMSA's combined inspection programs and safety regulations, but an individual inspection scheduling tool, like RRIM, does not need to address each factor.

Pipeline Age and Manufacturer

Annual reports submitted to PHMSA by pipeline operators include the number of miles by decade of installation and by-State and by-Interstate/Intrastate status. RRIM calculates a risk score at the Unit level and, for larger operators, miles by decade of installation from the annual report cannot be parsed to individual Units. PHMSA is not aware of any other source of data for pipeline age, yet. In calendar year 2028, PHMSA's National Pipeline Mapping System is expected to begin collecting decade of installation at the Geographic Information System (GIS) segment level for gas transmission, hazardous liquid, and carbon dioxide pipeline systems as-of 12/31/2027. Since PHMSA already has Unit ID at the GIS segment level, we would be able to include decade of installation as a factor when calculating Unit risk score. During calendar year 2028, PHMSA expects to process thousands of NPMS submittals with decade of installation data. The earliest that Unit decade of installation data could be used in RRIM would be the 2029 run for year 2030 planning.

PHMSA is not aware of any pipe manufacturer data that could be parsed to individual Units.

Volume Transported

Hazardous liquid and carbon dioxide annual reports submitted to PHMSA by pipeline operators include the barrel-miles of commodity transported by the operator. RRIM calculates a risk score at the Unit level and barrel-miles transported from the annual report cannot be parsed to individual hazardous liquid and carbon dioxide Units.

Gas transmission annual reports submitted to PHMSA by pipeline operators include the volume of commodity transported by the operator unless the gas transmission lines are operated by a gas distribution company as an integral part of its distribution pipeline system. RRIM calculates a risk score at the Unit level and volume transported from the annual report cannot be parsed to individual gas transmission Units.

PHMSA is not aware of any volume transported data that could be parsed to individual Units.

Pressure

Annual reports submitted to PHMSA by pipeline operators include the number of steel pipeline miles by hoop stress as a percent of Specified Minimum Yield Strength (SMYS) and by-State and by-Interstate/Intrastate status. RRIM calculates a risk score at the Unit level and, for larger operators, steel miles by hoop stress as a percent of SMYS from the annual report cannot be parsed to individual Units. PHMSA is not aware of any other source of data for pipeline pressure.

Seismicity

Based on incident data submitted by pipeline operators, seismicity is a negligible threat to pipeline integrity and should not be a factor in RRIM.

Climate and Geology

PHMSA recognized that land movement is a significant threat to pipeline integrity. We investigated GIS data layers for soil type and slope and found raster data sets. However, it is not feasible to build a national GIS layer with sufficient granularity for use in RRIM. We investigated using the locations of gas gathering/transmission, hazardous liquid, and carbon dioxide incidents due to land movement and rain/flood to build a buffer map. Pipelines passing through the buffered areas would have a higher land movement threat factor with the closest pipelines having the highest threat factor. The Land Movement threat factor was implemented in the 2024 run.

Demography

Merriam-Webster defines demography as the statistical study of human populations especially with reference to size and density, distribution, and vital statistics. Population density affects whether a pipeline segment is considered a high consequence area (HCA) under PHMSA's integrity management regulations. When the RRIM Consequence Factor is calculated for a Unit, pipeline segments in HCA get a significantly higher weight than segments outside of HCA. Demography is already a factor in RRIM.

Appendix 6 Regression Analysis

After each year's RRIM run, PHMSA updates the regression analysis. PHMSA evaluates the relationship between incidents occurring in a unit and the unit's threat index factors. We use this regression analysis to confirm that the results of the SME threat index factor weight evaluations are consistent with unit incident histories. The regression analysis shown in Table 1 analyzed significant incidents from 2019 – 2025 compared to the 2018 through 2024 RRIM runs.

Calculating the "P Value" is a statistical test for the probability of association. A "P Value" less than 0.05 is commonly accepted as a statistically significant demonstration of association. The odds ratio column represents an increased chance of having an incident. For example, if the Mileage factor has an odds ratio of 3.0, a shift in Mileage weight from a lower value to the next higher value creates a 3.0 times greater chance that the unit would have an incident. A 95 percent confidence interval was used to calculate the range of the odds ratio.

Since the "P Values" in Table 1 are less than 0.05, the odds ratios are greater than one, and the confidence interval range values are consistent with the odds ratio, the relationship between those threat factors and incident histories are statistically significant. This confirms the validity of the SME factor weight evaluations for those threat factors.

The Bare Pipe and Ineffective Coating threat factors have had a low or insignificant P value for the last few years. However, some members of the RRIM Team advocated for keeping the factors in the algorithm until better data sources are identified.

Table 1: Regression Analysis for RRIM Threat Factors at the 95 Percent Significance Level
Based on data from 2018-2024 RRIM Runs

			95% Confidence Interval of the Odds Ratio	
Threat Factor	**P-Value**	**Odds**	**Lower**	**Upper**
Mileage	<.0001	4.3	3.6	5.0
ERW Mileage	<.0001	1.4	1.2	1.7
Enforcement	<.0001	1.3	1.2	1.4
National Registry Notification	NS	0.7	0.3	1.9
Commodity	<.0001	1.1	1.1	1.2
Bare Pipe	NS	4.0	0.3	53.6
Ineffective Coating	<0.05	25.4	4.2	155.3
Significant Incidents	<.0001	1.8	1.7	2.0

Appendix 7 Sensitivity Analysis

After each year's run, PHMSA updates our sensitivity analysis. A model's sensitivity analysis is commonly understood as the study of how uncertainty in different model inputs can affect the model outputs. In the case of RRIM, model inputs are the risk factor values and weights in the RRIM threat and consequence indices. The model output is the risk score calculated for each unit based on the risk factor values and weights. One of the simplest and most common sensitivity analysis approaches is changing one factor at a time. This involves setting a factor to zero weight value for all units while holding all other factors at their assigned values, then repeating this process for each factor in turn. Each RRIM factor's overall contribution to the model is measured by monitoring the changes in the average unit risk score.

Table 2 shows the results of this type of sensitivity analysis on the 2025 run. This analysis demonstrates that the factors with the greatest overall impact on the risk score are enforcement, commodity, and the consequence index score, and the risk score was sensitive to the removal of these factors. The low values for Bare Pipe and Ineffective Coating confirm the lack of impact these factors have, as demonstrated in the regression analysis.

Table 2: Average Change in Unit Risk Score When Factor Is Removed
Based on 2025 RRIM Run

RRIM Factor	Average Change in Unit Risk Score
Mileage Weight	6.0
ERW Mileage Weight	1.9
Enforcement Weight	10.6
National Registry Notification Weight	<1
Commodity Threat Weight	55.4
Bare Pipe Weight	<1
Ineffective Coating Weight	<1
Significant Incidents Weight	4.2
Land Movement Threat Weight	7.3
Consequence Index Score	80.1

Appendix 8 Effectiveness Measures

PHMSA has established two measures of effectiveness: average inspection system inspection effort per tier and average unit factor values per tier.

Average Inspection System (IS) Inspection Effort per Tier

The basic premise of RRIM is that IS in the High tier contain more risk than IS in the Medium tier, and that IS in the Low tier have less risk than IS in the Medium tier. The most direct indicator of the veracity of this premise is the amount of effort expended by the inspection team.

Experience tells us that some inspections of IS may continue after the end of the year in which they begin. Around late July of each year, PHMSA uses effort data for integrated and first operating inspection started in the previous year and calculates the average IS inspection effort for each tier. If the inspection effort does not align with the risk tier as stated above, PHMSA will investigate the reasons for the discrepancy. If the investigation indicates that changes should be made to RRIM to better reflect IS risk, the RRIM Team will work to identify appropriate changes. Table 3 is based on integrated inspections started in CY 2025 and the IS risk tier from the 2024 RRIM run. This effectiveness measure supports the premise that IS in higher risk tiers represent a higher risk requiring more inspection effort.

Table 3: Average Inspection Effort per Risk Tier
Based on inspections started in CY 2025 and the 2024 run risk tier

Risk Tier	Number of IS	Average Inspection Effort in Days
High	72	71.18
Medium	67	39.25
Low	27	19.56

Average Unit Factor Values per Tier

If RRIM accurately calculates relative risk based on the input factors, the average factor value for units in High risk tier Inspection Systems (IS) should be higher than the average factor value for IS units in the Medium tier, and IS units in the Low tier should have average factor values lower than the average factor value for IS units in the Medium tier.

Shortly after the annual RRIM run, PHMSA calculates the average unit factor values and presents the results based on the unit's IS risk tier. If an average factor value does not align with the risk tier as stated above, we will investigate further to determine if a change to RRIM is needed to provide more meaningful factors. Table 4 shows the average unit factor values from the 2025 RRIM run by IS tier.

The flat value for Bare Pipe and nearly flat value for Ineffective Coating support the determination that these factors do not effectively differentiate between risk levels.

Table 4: Average Unit Factor Values per Tier
Based on the 2025 RRIM Run for FY 2026 inspection planning

Factor	**High Tier**	**Medium Tier**	**Low Tier**
Average of Mileage Weight	0.542	0.394	0.116
Average of ERW Mileage Weight	0.201	0.123	0.024
Average of Enforcement Weight	1.031	0.733	0.328
Average of Notification Weight	0.047	0.055	0.036
Average of Commodity Threat Weight	4.705	4.591	3.406
Average of Bare Pipe Weight	0.005	0.007	0.003
Average of Ineffective Coating Weight	0.009	0.006	0.004
Average of Significant Incidents Weight	0.420	0.236	0.128
Average of Land Movement Threat Factor	0.722	0.463	0.089
Average of Consequence Index Score	19.719	12.470	5.679