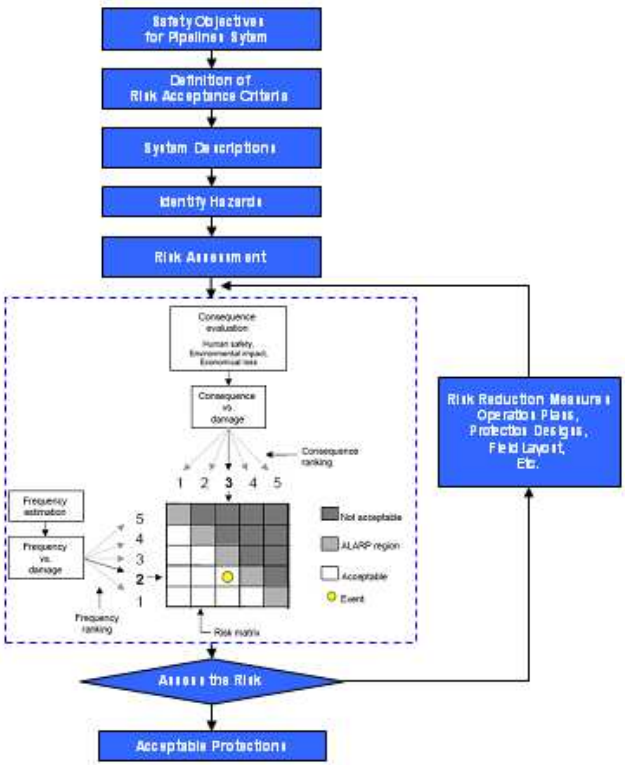
H.QRA - HSEAll Tools for Quantitative Risk Assessment

HSEAll QRA Tools Kit: 04 modules

1. H.QRA Plant - HSEAll QRA Tool for Onshore Installations;
2. H.QRA Pipelines - HSEAll QRA Tool for Onshore Pipelines;
3. H.QRA Platform - HSEAll QRA Tool for Offshore Platforms;
4. **H.QRA Subsea Pipelines - HSEAll QRA Tool for Subsea Pipelines.**

H.QRA-Subsea Pipelines Module

1. HSEAll QRA Methodology for Subsea Pipelines:



Hazards Identification: Identify all potential hazards for subsea pipelines system;

Frequency Analysis:

- Quantitative Methodology for identified threats/hazards;
- User-friendly & Out-of-box calculations

Consequence Analysis:

- Qualitative Methodology for Human Safety, Environment and Economics;
- User-friendly & Out-of-box calculations

Risk Analysis & Assesment:

- Transparent Calculations and visualized on the Field Maps.

H.QRA Subsea Pipelines Methodology Statements:

- Commonly recognized Methodology for Quantitative Risk Assessments (QRA);
- Being developed and designed in accordance with DNV RP F107 – Risk Assessment of Pipeline Protection, October 2010.

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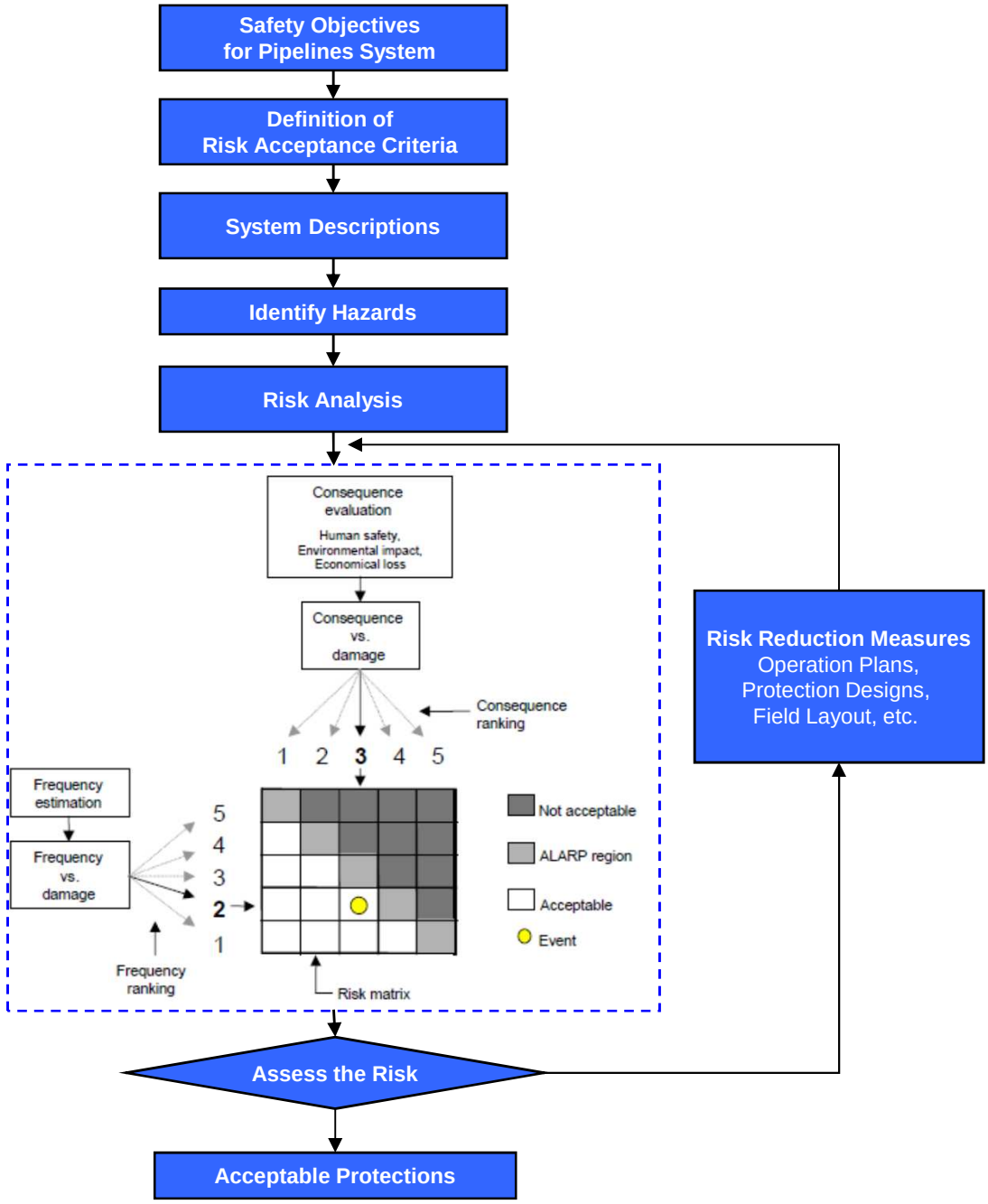
2. H.QRA Subsea Pipelines QRA Flowchart



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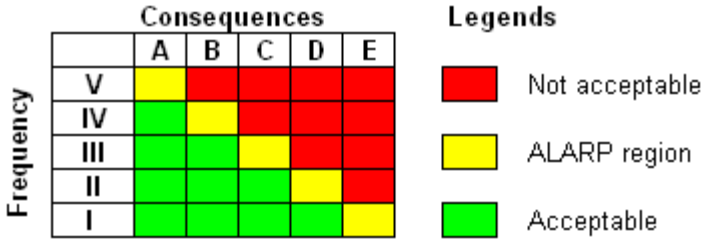
3. Risk Acceptance Criteria

The Risk Acceptance Criteria shall be established based on Company‘s Policy for the Activities. In this document, HSEAll proposes the Risk Acceptance Criteria recommended by DNV RP F107 – Risk Assessment of Pipeline Protection.

The Risk Acceptance Criteria is presented in the form of Risk Matrix:



H.QRA Subsea Pipeline software tool can reset/adjusted its set Risk Acceptance Criteria to be compliant with the Client’s Policy.

4. Hazards Identification

Hazards Identification (HAZID) process for Subsea Pipelines mainly focuses on identifying potential threats / impacts those may result in releases of hazardous substances. HAZID can be in the form of Expert Judgments and/or HAZID Workshops.

Bascially, H.QRA Subsea Pipelines tool has integrated following Threats:

H.QRA Subsea Pipelines can also allow to integrate any additional Threats as being identified during HAZID sessions.

No.	Threats / Hazards	Sub-threats
1.	Internal Damages	
1.1		Corrosion
1.2		Others
2.	Dropped Objects	
3.	Shipping Operations	
3.1		Collisions
3.2		Emergency Anchoring
3.3		Sunken ships
4.	Fishing Boats (bottom trawling)	
5.	Subsea SIMOPS	
5.1		Drilling
5.2		Completion
5.3		Intervention
5.4		ROV impact
6.	SIMOPS-Construction	
7.	Natural Hazards	

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5. Leak Frequencies Analysis

Generic Leak Frequencies:
Pipelines and its integrated systems have its generic leak frequencies; those are leaks frequencies by the nature of the systems. Generic Leak frequencies can be found in the worldwide accident statistics and to equipment failure databases.

Dropped Objects Impacts
The dropped objects from the potential heavy lifting activities on neighboring platforms, ships, etc., may hit the subsea pipelines leading to accidental damages and releases. The lifting activities are specific for the pipelines system in consideration.

Shipping Operation Impacts
The Ship Operations may cause adverse impacts to the subsea pipelines such as collisions, anchoring, dropped objects, sunken ships, etc. leading to accidental damages and releases. The shipping operations are different for specific pipelines system and also specific segments of the pipelines.

Fishing (trawling) Impacts
Trawling impacts are one of concerns for subsea pipelines systems. Trawling impacts may cause adverse impacts to the subsea pipelines such as displacements, protections damages, break and ruptures, etc. leading to accidental damages and releases. Trawling impacts are considered third parties activities and are different for specific pipelines system and also specific segments of the pipelines.

SIMOP Drilling Activities & Construction Activities Impacts
When drilling campaign is carried out, it will cause adverse impacts to the subsea pipelines. Similar to drilling, SIMOP constructions and modifications may badly influence to subsea pipelines safety:

Natural Hazard Impacts: Natural disasters can be one of concerns for the safety of the subsea pipelines systems, such as earthquakes, land slides, tsunami, ect.

Leak Frequencies by all identified hazards will then be summed and ranked in 5 categories as follows:

Table 13 Annual failure frequency ranking for one pipeline/umbilical

Category	*Description*	*Annual frequency*
1 (low)	So low frequency that event considered negligible.	$<10^{-5}$
2	Event rarely expected to occur.	$10^{-4} > 10^{-5}$
3 (medium)	Event individually not expected to happen, but when summarised over a large number of pipelines have the credibility to happen once a year.	$10^{-3} > 10^{-4}$
4	Event individually may be expected to occur during the lifetime of the pipeline. (Typically a 100 year storm)	$10^{-2} > 10^{-3}$
5 (high)	Event individually may be expected to occur more than once during lifetime.	$>10^{-2}$

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6. Consequence Analysis

Consequence Analysis for offshore pipelines can be considered semi-quantitative methodology, where the consequences are ranked based on pipelines fluid, human presence and technical judgments. No detailed calculations on dispersion, ignitions, heat radiations, etc. are required. It can be explained that for the subsea pipelines, there are many uncertainties such as hazardous fluid floated to sea surface, low possibility of ignition sources, low possibility of human presence, etc. Hence, fire and explosion are rare occurrences; together with low human presence, it makes fire and explosion and their impacts are not major concerns.

Potential consequences of accidental events to pipelines and umbilicals must be established with consideration human safety, economic loss and environment impacts. The Table below presents a matrix for identifying of potential consequences for damage to pipelines and umbilicals.

Table 14 Identifying potential consequences for pipeline and umbilical damage

Pipeline contents	*Human safety*	*Environmental impact*	*Material damage*
Gas	Relevant	Normally not relevant[4]	Relevant
Condensate	Relevant	Relevant[1]	Relevant
Oil	Relevant	Relevant	Relevant
Water	Normally not relevant	Relevant[5]	Relevant
Umbilical	Normally not relevant[2]	Normally not relevant[2,3]	Relevant

The consequences are ranked on 5 categories for Human Safety, Environment & Economic losses as follows:

Category	*Description*
1 (low)	No person(s) are injured.
2	(not used)
3 (medium)	Serious injury, one fatality (working accident)
4	(not used)
5 (high)	More than one fatality (gas cloud ignition)

Category	*Description*	*Amount of release*
1 (low)	Non, small or insignificant on the environment. Either due to no release of internal medium or only insignificant release.	~ 0
2	Minor release of polluting media. The released media will decompose or be neutralised rapidly by air or seawater.	<1000 tonnes
3 (medium)	Moderate release of polluting medium. The released media will use some time to decompose or neutralise by air or seawater, or can easily be removed.	<10000 tonnes
4	Large release of polluting medium which can be removed, or will after some time decompose or be neutralised by air or seawater.	<100000 tonnes
5 (high)	Large release of high polluting medium which can not be removed and will use long time to decompose or be neutralised by air or seawater.	> 100000 tonnes

Category	*Description*	*Production delay/ Downtime*
1 (low)	Insignificant effect on operation, small or insignificant cost of repair	0 days
2	Repair can be deferred until scheduled shutdown, some repair costs will occur.	<1 month
3 (medium)	Failure causes extended unscheduled loss of facility or system and significant repair costs. Rectification requires unscheduled underwater operation with pre-qualified repair system before further production.	1-3 months
4	Failure causes indefinite shutdown and significant facility or system failure costs. Rectification requires unscheduled underwater operation without pre-qualified repair system before further production. Or Failures resulting in shorter periods of shut down of major parts of (or all of) the hydrocarbon production for the field.	3-12 months
5 (high)	Total loss of pipeline and possible also loss of other structural parts of the platform. Large cost of repair including long time of shut down of production. Or Failures resulting in shut down of the total hydrocarbon production for a longer period.	1-3 years

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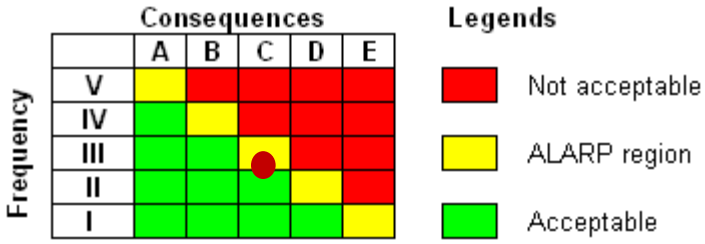
7. Risk Assessment

The final risk assessment consists of coupling the relevant frequency rankings with the consequence rankings and then comparing the result against the acceptance criteria.

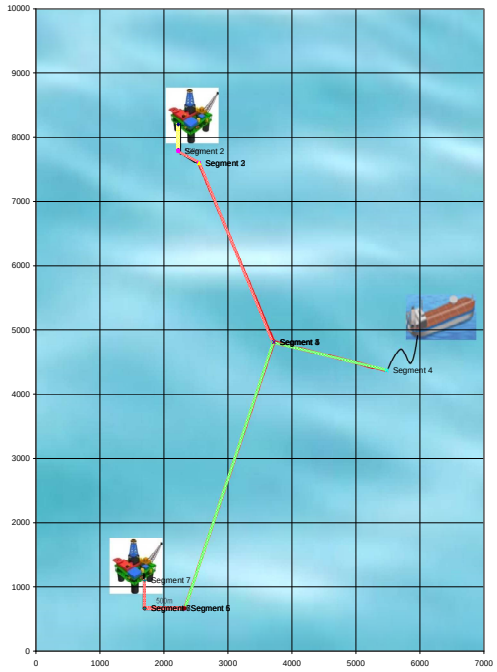


H.QRA Subsea Pipelines tool calculates Risk levels of all pipelines segments:

SUBSEA PIPELINES RISK ASSESSMENT RESULTS

No.	Segment	Frequency Analysis		Consequence Analysis	Risk Combinations	Risk	Risk Zone
		Value	Level Range				
1	Segment 1	2.00E-04	III (Medium)	c	III (Medium)-c	Yellow	ALARP
2	Segment 2	2.00E-05	II	C	II-C	Red	Intolerable
3	Segment 3	1.00E-05	I (Low)	E	I (Low)-E	Red	Intolerable
4	Segment 4	1.20E-02	V (High)	A	V (High)-A	Green	Tolerable
5	Segment 5	2.00E-03	IV	C	IV-C	Green	Tolerable
6	Segment 6	1.00E-06	I (Low)	C	I (Low)-C	Red	Intolerable
7	Segment 7	1.00E-05	I (Low)	C	I (Low)-C	Red	Intolerable
8					-		
9					-		
10					-		

H.QRA Subsea Pipelines tool will then present the pipelines segment Risk Levels, by colors set for specific Risk Levels, to the Pipelines system Field Map.



If the risk level is not acceptable, then mitigation measures should be taken to reduce the risk. The length of pipeline to be protected should be so that the overall risk of both the protected and the unprotected parts are acceptable.

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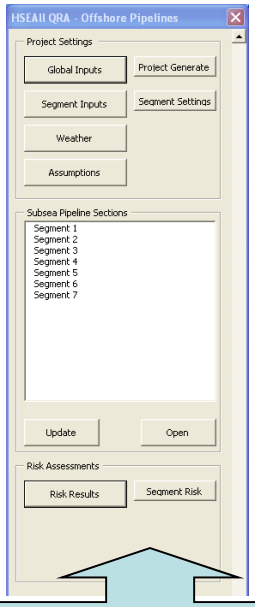
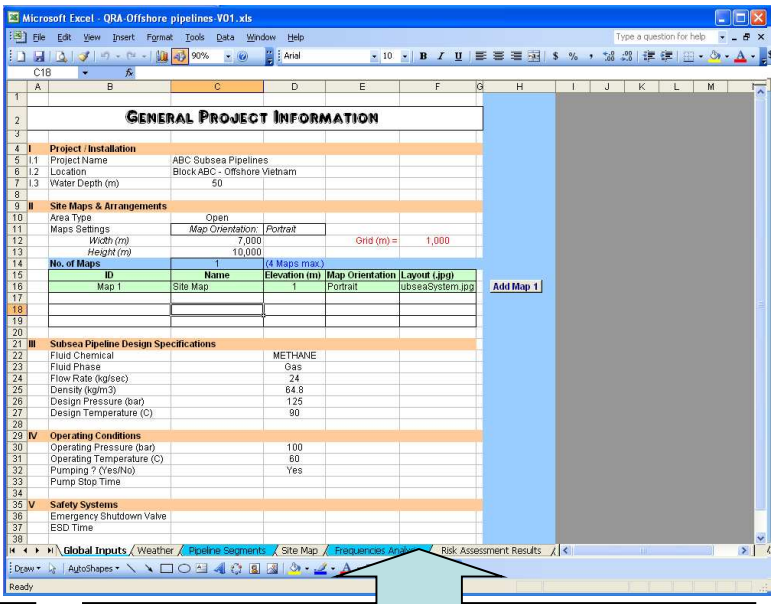
8. H.QRA Subsea Pipelines Interfaces:

a.

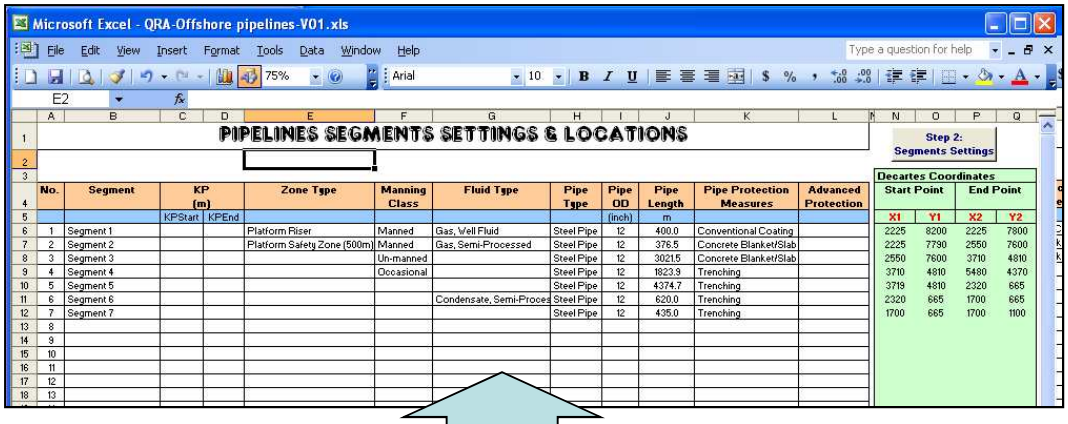




Navigator Section guides Users throught out the QRA process.

Calculation Worksheets section presents Project Inputs and Data, Maps, Frequency and Consequence calculations and Risk results.

b.



Operational parameters are input into H.QRA software tool: Pipelines segment Names and IDs, KPs, Fluid, Types, Manning, Pipes Specifications, Length, Segment Coordinates, Protection measures, etc..

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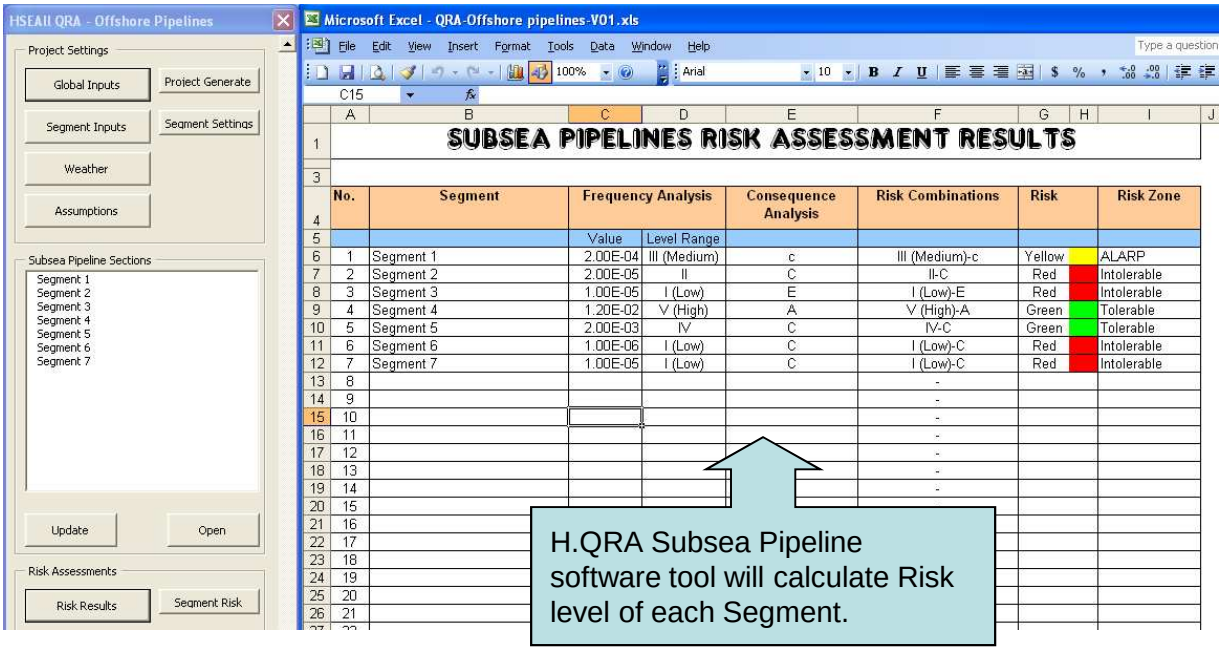
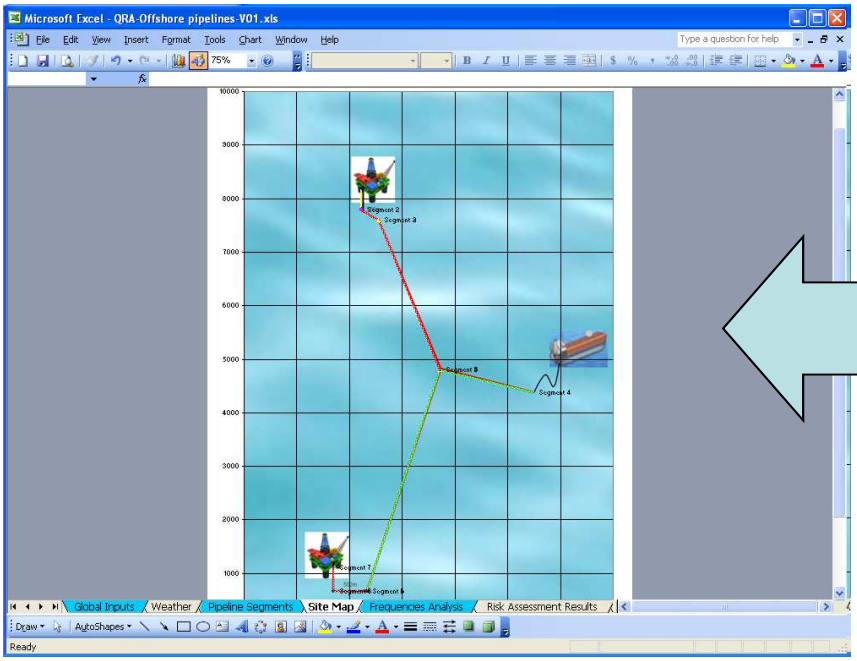
8. H.QRA Subsea Pipelines Interfaces: (continued)

c.



d.



H.QRA Subsea Pipelines tool will then present the pipelines segment Risk Levels, by colors set for specific Risk Levels, to the Pipelines system Field Map.

Email Us at HSEAll@HSEAll.com to request further demonstrations.