

A SIMPLE METHOD OF RISK/HAZARD ASSESSMENT IN DREDGING

T. M. Verna¹ and L. A. Prieto-Portar²

ABSTRACT

The assessment of the hazards and assignment of risk of each activity of a project is an important part of preparing a bid for a dredging project. Although there are many sophisticated software available to assess risk based on Monte Carlo simulation, they are usually expensive and require highly specialized personnel. This paper proffers a simple risk analysis matrix that can be used by the smallest of dredging firms, literally “on the back of an envelope”. It is based on the assessment of each activity’s severity and probability of occurrence. The activity’s severity is defined as the degree of, (1) the injuries sustained, (2) the environmental damage, (3) system damage, and (4) financial loss. The probability assesses how often these risks could occur during the lifetime of the project. The risk matrix then puts it all together as a simple procedure to mitigate all the risks down to acceptably safer levels.

Keywords: Risk analysis matrix, process hazard analysis, assessed severity, probability of occurrence, dredging.

INTRODUCTION

A dredging process hazard analysis (PHA) is a systematic identification of the potential hazardous scenarios within a dredging operation. Many federal agencies are now requiring firms to perform PHAs during their mobilization phase. For example, the Occupational Safety and Health Administration (OSHA) and the U.S. Environmental Protection Agency (EPA) require that PHAs be performed before a contract becomes operational, and are mandatory for all new processes or when modifications are made to the original PHA. The U.S. Army Corps of Engineers requires that Accident Prevention Plans address the risk associated with each task when preparing a PHA (the USACE uses the synonymous term Activity Hazard Analysis). PHAs shall define the activities being performed and identify the work sequences, the specific anticipated hazards, site conditions, equipment, materials, and the control measures to be implemented to eliminate or reduce each hazard to an acceptable level of risk (USACE 2008).

Teamwork is central to preparing a PHA. In order to meet OSHA requirements, PHAs must be conducted by a team using a defined methodology. Teams must include (1) a facilitator familiar with the chosen methodology, (2) specialists in the process being examined and (3) persons familiar with the operations and maintenance procedures in place for the process. One commonly used methodology is a Hazard and Operability Study (HAZOP), in which the process is broken down into small sections called nodes (activities). Using a series of guide words that stimulate brainstorming, the team examines each node (activity). Members consider possible deviations from the design intent for process parameters. For example, process nodes or activities could be the dredging depth, the type/size of solids in the slurry, the length and discharge diameter of the pipeline, the number of boosters on line, etc. The team discusses the potential hazardous consequences of deviations and the safeguards that are in place. The potential hazardous scenarios are then assigned a risk ranking based on the likelihood (probability) of a given deviation and the severity of the consequences, and summarized on a risk matrix.

THE DREDGING RISK MATRIX

A generic risk matrix is shown in Figure 1 below. The risk assessment team establishes for each identified risk “item” its level of severity (the impact upon the project, or outcome/degree of the incident, near miss or accident) and its corresponding probability of occurrence (how many times that risk event can occur, or likelihood of the hazard to cause an incident, near miss, or accident). The result is that each item is assessed a level of risk (ranging from very high to very low). Once the level of risk is determined for the severity (x-axis of chart) and probability (y-axis of chart), a Risk Assessment Code (RAC) is selected for each hazard. This assessment and selection is then continued for each identified hazard in the PHA.

¹ Civil Engineer, U.S. Army Corps of Engineers, Institute for Water Resources, 7701 Telegraph Road, Alexandria, Virginia 22315, USA, T: 703-428-8562, Fax: 703-428-8459, Email: Thomas.m.verna@usace.army.mil.

² CEO, Piedroba Marine Construction, 3250 Grand Avenue, Suite 201, Miami, FL 33133, USA, T: 305-972-2779, Email: dr.prieto@piedroba.com / Professor, Department of Civil and Environmental Engineering, Florida International University, Miami, FL 33176.

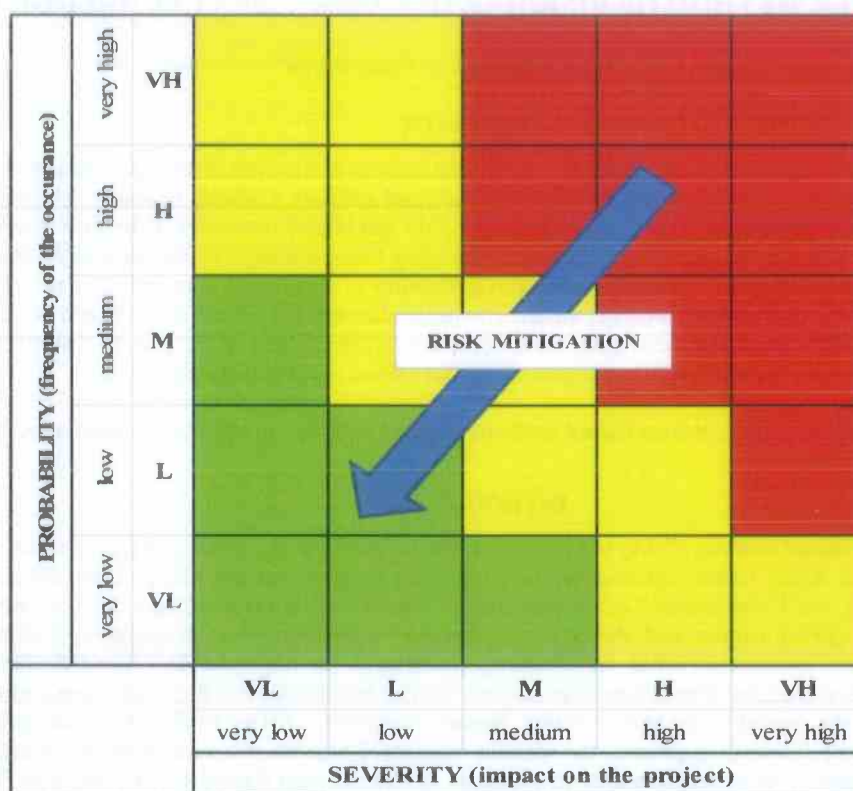


Figure 1. The dredging risk matrix.

The terms used in the risk matrix are defined in Table 1.

Table 1. Definition of Risk Terminology			
Probability (P)		Severity (S)	
VH	Very High Likely to occur often (expected).	VH	Very High Death/severe environmental or financial damage/ >50M\$
H	High Will occur several times during the project	H	High Severe injury/major environmental or financial loss/ >25M\$
M	Medium (moderate) Occurs once during the project	M	Medium (moderate) Light injury or system damage/ >1M\$
L	Low Unlikely, but might occur once.	L	Low Light injury or system damage/ >0.5M\$
VL	Very low Not expected at all.	VL	Very low No injuries/irrelevant environmental or financial losses/ <0.1M\$

Red	Unacceptable; must be reduced.
Yellow	Reduce if feasible; proceed with caution.
Green	Proceed and keep monitoring.

The actual definition of financial thresholds will vary from project to project. To be effective, the next step is to use the RAC and determine the equipment, training, and inspection to properly and safely perform the work. Further QA/QC enhances safe work practices until the job is completed.

EXAMPLE PROJECT: A Beach Renourishment Project.

This simple method of risk assessment can be demonstrated by an example prepared by one of the authors for a major beach renourishment project planned for South Beach, Miami, Florida (Prieto-Portar and Ozcan, 2008). The following items were initially identified as potential risks:

<i>Risk Item #</i>	<i>Definable Feature of Work</i>
1.	Delays in the project will cause major economic damage to the local economy.
2.	Existing utilities, roadways, and other infrastructure are damaged during the project.
3.	Reportable/lost work injuries occur.
4.	Design errors and omissions impact the project.
5.	Violations of noise and vibration restrictions.
6.	Impact of non-complaint maintenance of traffic.
7.	Encountered unexpected subsurface obstructions.
8.	Insufficient space for operations hinders productivity.
9.	Untimely approval of permits and access to areas of operations.
10.	Unidentified risks.

Each project will have its own characteristic list. The experience of each of the team members becomes critical in identifying realistic risks. A novice in risk management will learn from the experienced senior members. The clarity of the causes of past experiences, both good and bad, will contribute to their mitigation.

Applying the risk mitigation rules of severity and probability to the first “risk item #1” above will yield the following first line of the final risk mitigation matrix, shown in Table 2 below.

<i>Table 2. Example of Risk Mitigation for a Beach Renourishment Project.</i>						
<i>No.</i>	<i>Identified Risk</i>	<i>Risk</i>		<i>Risk Mitigation</i>	<i>Residual Risk¹</i>	
		<i>S²</i>	<i>P³</i>		<i>S</i>	<i>P</i>
1	Delays	H	M	1- Closer coordination with City's DPW management; 2- Expedite the procurement process to <180 days; 3- Re-sequence the CPM with all parties to reduce project time; 4- Provide Early Finish (EF) incentives.	H	L

Notes:

- Residual Risk** is by definition the Risk after the Risk Mitigation has been implemented.
- Severity** is determined by the experience of the team's consensus decision-making action.
- Probability** is the frequency of risk events determined by the experience of the team's consensus.

Notice how the mitigation measures have not affected the severity (still *H*), but the probability was reduced from medium (*M*) to low (*L*), which now permits the project to proceed, albeit “with caution”. Further mitigation ideas could actually reduce the probability to very low (*VL*). That will result in this activity becoming a “GREEN: Good to Go”. The rest of the table with the remaining nine identified risks is provided in Table 3 shown below.

Risk Mitigation Table						
No.	Identified Risk	Risk		Mitigated Risks	Residual Risk	
		S	P		S	P
1	Delays in the project	H	M	1- Closer coordination with City's DPW management; 2- Expedite the procurement process to <180 days; 3- Resequence CPM with all parties to reduce time; 4- Provide Early Finish (EF) incentives;	H	L
2	Damage to utilities	M	VH	1- Closer coordination with County's WASD; 2- Redraw "as-builts" with latest GPS database; 3- Instrument ground movement with seismic-meters; 4- Provide isolation devices to mitigate stress;	L	L
3	Reportable injuries	H	M	1- Hire more flagmen and safety inspectors at beach; 2- Discuss PHA with crew before starting activity; 3- Initiate Plans and Pre-Construction Meetings; 4- Return to Work Clerks;	H	L
4	Design E&O	VH	M	1- Pre-qualify the experience of all design elements; 2- Implement QA/QC Plan based on ISO 9001-2010; 3- Implement a Peer Review program; 4- Provide independent one-day checks by experts;	H	L
5	Noise and vibrations	M	M	1- Prior survey of existing noise and vibrations; 2- Revise Performance Specs to acceptable standards; 3- Instrument with noise meters and seismographs;	L	L
6	MOT violations	VH	H	1- Implement a Maintenance & Protection Plan; 2- Implement Manual of Uniform Traffic Control Devices 3- Implement a Traffic Control Plan; 4- Provide Signals and Signs;	M	L
7	Subsurface obstructions	M	M	1- Review all existing geo-data from all county sources; 2- Redraw up-to-date profile of work area: redline danger 3- Side scan radar redlined areas; 4- Contingency plans for encountered obstructions;	M	L
8	Space restrictions	M	VL	1- Apply Best Management Practices; 2- Provide temporary easements of sufficient size; 3- Provide off-site storage/parking/field office + shuttle;	L	VL
9	Late permit approvals	H	M	1- Closer coordination with DEP, USACE, WASD, PoM; 2- Keep daily track of progress and warning of delays 3- Account for approval process of CPM schedule; 4- Provide PIO for all authorities having jurisdiction AHJ	H	VL
10	Unidentified risks	M	L	1- Maintain weekly PHA identification meetings; 2- Qualitative approach first, then quantitative if needed 3- Set up team of competent and experienced members 4- Moderate by experienced risk manager.	L	L

CONCLUSIONS

Dredging and marine construction is inherently dangerous. The risk assessment process described in this paper is a tool to help identify hazards and formulate controls to reduce the hazard to an acceptable risk level. Communication throughout all levels of the project is key to success in reducing risk, and getting the job done in a safe and timely manner. However, it doesn't stop there. As the work progresses and technology and personnel changes, the AHA needs continuous attention to revise and update the RACs.

This paper has presented a simple and easy to use method of risk mitigation that can be used by all the members of a construction team. In fact, these members will typically be the initial PHA team. The risk matrix can also be shared with governmental officials (city's department of public works, in this example), and with other permitting agencies. The simplicity of the matrix permits all of them to contribute practical advice to reduce time, personnel and funding with concomitant reductions in risk. Safety requires a Team effort!

REFERENCES

USACE, *Safety and Health Requirements Manual*, U.S. Army Corps of Engineers, EM 385-1-1, 15 Sept 2008, paragraph 01.A.13.a;
Prieto-Portar, L., Ozcan, G., "A Generic Risk and Vulnerability Assessment Framework", American Society of Civil Engineers, *Proceedings of the South Florida Annual Meeting*, Naples, July 2008.

CITATION

Verna, T. M. and Prieto-Portar, L. A. "A simple method of risk/hazard assessment in dredging," *Proceedings of the Western Dredging Association (WEDA XXXII) Technical Conference and Texas A&M University (TAMU 43) Dredging Seminar*, San Antonio, Texas, June 10-13, 2012.