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No doubt because of strong criticisms commenters raised regarding the earlier Draft EIR, this Revised DEIR for the Benicia Valero Crude by Rail Project in fact **has remedied some of the most glaring defects** of the earlier document. But there are still several issues with the RDEIR's presentation of the validity and reliability of its Quantitative Risk Assessment [QRA, also known as PRA and in transportation as TRA] methodology that raise serious concerns for citizens and officials. The inherent and large uncertainties in the methodologies employed are great, but they get only pro forma and meager attention, the caboose to the speeding train of the current RDEIR presentation, so to speak.

First one should put in perspective that the whole QRA presentation in Appendix F and in the overall RDEIR is only one major component, although a key one, of the overall public comment and public official decision process involved in approving or not the Valero Crude by Rail [CBR] Project. Citizens and public officials must take make, on the basis of the information on major crude oil release accident consequences and probabilities, an overall calculation of costs and benefits of alternatives, and finally public officials must make a decision on what is termed in chemical risk discussions the "tolerability of the risk."

Even if the locality may not <u>demand</u> major changes in mainline rail operations because of federally preemptive laws protecting railroads' decision rights to operate as they will, **the locality has considerable leverage over approval** of the fixed facility for unloading the crude oil trains for refinery use. Most jurisdictions in the US, and in fact most nations, have no federal "risk tolerability" standards, although some in Europe are beginning to discuss these.

The RDEIR's QRA presentation is clearly designed to impress readers as if it were so wide in scope and technically sophisticated that its validity is beyond question.

In fact, however, there is a flood of **un-transparent engineering judgments and key assumptions** throughout the document which mainly remain out of sight and unacknowledged, so the authors' results are virtually unaccountable to any real scrutiny. The RDEIR, like the earlier document, relies on the MRS and Barkan consultants' "black box" proprietary risk models and proprietary data from industry sources, so it yields an analysis which is in key aspects un-transparent and unaccountable.

Citizens and officials need some way of evaluating the RDEIR's analysis and conclusions. Unfortunately the current document is difficult to assess, at least without one's own pricey consultant, but at least there are some useful sources that can assist citizens to appreciate **the need for an appropriate level of skepticism regarding the seemingly ultra-scientific RDEIR's QRA calculations and conclusions.**

All QRA practitioners surely know, even if local officials and agency professionals cannot be expected to, the blockbuster **2004 "Benchmark report" from the European Commission** that showed how different prominent QRA methodologies in use worldwide can lead to **astonishingly large differences** in accident risk estimates [key calculated risk results sometimes varying 10 times, 100 times, or 1000 times smaller or larger], and how a large range of uncertainties can impact such calculations. [See End Note 1]

The City's consultant Professor Christopher Barkan from the University of Illinois Urbana Champaign's RailTec Institute, is the leader of a virtual railroad industry research shop, whose graduate students and professors draw financial support and copious amounts of rail road data from BNSF Railroad and the Association of American Railroads, as they readily credit in their published reports. Barkan's report [Attachment 1 in Appendix F of the RDEIR] lists some caveats only pro forma, briefly and at the end of his report [p. 12], in part to blunt the critics who would doubt that his predictions of very low probability for Crude By Rail accidents can be true given the ongoing oil train accidents in 2015:

4.5. Caveats

The nature of risk analysis is that even if an event has a low likelihood of occurring, there is no guarantee that it will not. For example, even if the estimated probability of an event is 0.01, i.e. one in one hundred, corresponding to an expected interval between occurrences of 100 years, such an event could still happen in the near future, and in fact multiple events are possible within that time period. Such an occurrence would not mean that the risk analysis was incorrect, instead it may be due to two factors, the laws of chance, and uncertainty in the statistics. It is important that readers understand this and that statements to this effect be included in reports used to describe the results of analyses of this nature.

From well-known American sources, since the RDEIR often cites the US chemical industry's Center for Chemical Process Safety at the American Institute of Chemical Engineers [CCPS and AIChE] http://www.aiche.org/ccps as the authoritative experts on the still-developing QRA methodologies, **we will cite some information and excerpts from the multi-year series of CCPS Guidelines books [for use by corporate and large chemical facility management] to underscore some of our concerns** about the RDEIR.

This review of CCPS guidance will also suggest that there are simpler and much less expensive risk assessment methodologies that the City could have chosen to assess the risks of the proposed project.

In fact, even US DOT's Pipeline and Hazardous Materials Safety Administration, in its 2014 Draft Regulatory Impact Analysis for its rulemaking on High Hazard Flammable Trains [crude oil and ethanol unit trains, HHFT] **explicitly chose not to use a full-blown QRA**. DOT used instead more of a semi-quantitative "consequence" approach -- based on a thorough analysis of recent Crude by Rail accidents, and not relying on overall rail accident rates for all freight traffic, since CBR is a different animal which has posed new disaster risks.

DOT's analysis nonetheless led to sober predictions of serious societal costs in likely future HHFT accidents and also usefully to DOT consideration of needed regulations for mitigations to reduce accident severity risks seen as significant.

See the DOT's Final Rule, the inadequacies of which the City's RDEIR does not take into account, at :

https://www.transportation.gov/briefing-room/final-rule-on-safe-rail-transport-of-flammable-liquids

A. **The City of Benicia in its RDEIR chose and leans heavily on a QRA method to evaluate Crude Oil Train release risks [assessing both consequences and probabilities]** and seemingly feels the need to present this choice in exaggerated fashion, asserting that QRA represents some broadly **accepted industry standards and government standards:**

1.

Regarding the City's assertion that QRA is some kind of state-of-the-art and widely used **government** standard for risk assessment, it seems true that there are several California jurisdictions that have used QRA methods to meet CEQA requirements to evaluate proposed high-risk projects, and arguably the City is legally free to use any method it chooses, namely in this case the same methods used in Santa Barbara:

"4.0 Significance Criteria [Appendix F, p. 38]

As defined in California Environmental Quality Act (CEQA) Guidelines Appendix G (the Environmental Checklist Form), a project could result in a significant safety effect if it "create[s] a potential health hazard or involve[s] the use, production or disposal of materials which pose a hazard to people, animal or plant populations in the area affected." The purpose of this study is to address the first two items in the CEQA Guidelines checklist for hazards and hazardous materials. These two items are:

a) Create a significant hazard to the public or the environment through the routine transport, use or disposal of hazardous materials;

b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment;

<u>California does not have a defined process to address these two items</u> from the CEQA checklist. Santa Barbara County adopted Public Safety Thresholds in August 1999 which established quantitative risk-based criteria that have been utilized by various state and local agencies, including the California Coastal Commission, the California State Lands Commission, the County of San Luis Obispo, Los Angeles County, City of Carpentaria, City of Whittier, City of Huntington Beach, etc. Therefore, the Santa Barbara County thresholds have been applied."

2. The City tries here to slip in an overall judgment of **risk tolerability [a separate decision outside the scope of the RDEIR]** into this technical discussion of what, in the technical Santa Barbara risk assessment methodology it has adopted [most likely without public discussion], might be considered a "significant" risk within the CEQA law's mandate of which risks bear detailed analysis:

*"The thresholds provide specific zones (i.e., green, amber, and red) on a risk profile curve to guide the determination of significance or insignificance based on the estimated probability and consequence of an accident. In general, risk levels in the green area **would be less than significant and therefore acceptable**, while risk levels in the amber and red zones would be significant. Risk profiles plot the frequency of an event against the consequence in terms of fatalities or injuries; frequent events with high consequence have the highest risk level.*

*The criteria used in this analysis are based on the potential risk associated with the crude by rail operations (operations at Refinery and along the UPRR mainline routes). Therefore, **an impact would be considered significant** if any of the following were to occur:*

• Be within the amber or red regions of the Santa Barbara County Safety Criteria; or

• Non-compliance with any applicable design code, regulation, NFPA standard, or generally acceptable industry practice."

In fact, full QRAs are still not widely used in the US, in part because of very high costs. And tellingly, the lack of reliability of the QRA approach is illustrated in the fact that in the earlier Draft EIR, the City found key Crude by Rail safety risks to be "insignificant", whereas now in the RDEIR these are characterized as "significant, but unavoidable" [for lack of identified risk mitigation measures that the City can order or create].

3. A full QRA, as the RDEIR states, has quite ambitious goals and wide scope:

"The main objective of the QRA is to assess the risk of generating serious injuries or fatalities to members of the public, to assess the risks of spill events, and to develop mitigation measures that could reduce these risks. The development of the serious injury and fatality aspects of the QRA ***involves five major tasks:***

- *Identifying release scenarios;*
- *Developing frequencies of occurrence for each release scenario;*
- *Determining consequences of each release scenario;*
- *Developing estimates of risk, including risk profiles;*
- *Compare the risk level to the significance criteria; and*
- *Developing risk-reducing mitigation measures." [p. 39]*

In fact, it is extremely difficult to imagine responsible scientists doing all these kinds of sophisticated calculations **without even knowing exactly what kind of hazardous cargoes** one is dealing with. "Crude oil" is a federal classification term covering broadly differing kinds of mined oil which can still be shipped in the federally-approved [inadequate] DOT-111 tank car. Various crudes [Bakken, tar sands, etc] are apparently possible for future shipments to Benicia Valero.

The official US government position is that, at least as oil industry representatives gleefully characterize it in opposing new strong federal regulation of Crude by Rail, "the science is still out" on what are the exact chemical and physical compositions, properties and behavior of various types of crude oils in transportation. The Department of Energy's Sandia National Labs just in 2015

issued a beginning survey of the literature and proposes a 10-year research program to get usable results:

"The report represents the most comprehensive survey of existing, publicly held data and analysis on the chemical and physical properties of tight crude oils completed to date. This survey helps to inform understanding of these characteristics, and in doing so provide context for ongoing efforts to ensure the safety of crude oil transport. Here's what we found:

The report confirms that while crude composition matters, no single chemical or physical variable -- be it flash point, boiling point, ignition temperature, vapor pressure or the circumstances of an accident -- has been proven to act as the sole variable to define the probability or severity of a combustion event. All variables matter.

There is some statistical evidence to suggest that Bakken crude has a higher true vapor pressure than other crude oils, however, the report identified a wide range of ways in which Bakken crude oil samples have been measured. Available analysis of tight crude oil does not provide the necessary data or conclusion to enable meaningful comparison with other crude oil. The report recommends additional research to identify the best way to collect and compare oil samples, while developing correlations between a particular property or set of properties and the likelihood or severity of rail transport-related combustion events.

The report is an important step in developing a more complete, science-based understanding of outstanding questions associated with the production, treatment, and transportation of crude oils. ***We are also working on an experimental plan that should give us more information on the correlation between certain oil properties and transportation safety."***

http://energy.gov/fe/articles/sandia-national-laboratories-releases-literature-survey-crude-oil-properties-relevant

4. The City has also asserted that the QRA methodology adopted in the RDEIR [among the many possible QRA methods outlined in the CCPS Guidance books] is a **"commonly accepted industry standard", citing CCPS and HSE :**

5.0 Risk Analysis *[Appendix F, p. 39]*

"The Project would result in the construction of new facilities that could lead to increased fire and explosion hazards at the Refinery and along the railroad routes to the Refinery. In assessing the level of public risk associated with these hazards a quantitative risk assessment (QRA) was conducted for both the new rail facilities at the Refinery as well as for the various mainline rail routes to the Refinery.

A QRA involves evaluating risks presented to the public by ***a facility or transportation operation*** *in the form of hazardous materials releases resulting in explosions, flammable vapors, or toxic material impacts. A QRA was used to evaluate the risks associated with* ***the transport of crude by rail along the main rail lines*** *between the Refinery and the Roseville Yard and the three mainline routes to Oregon (1 route) and Nevada (2 routes), and for* ***the rail operations that would occur at the Refinery****.*

The QRA analyzes the risks of immediate human safety impacts presented by these operations on nearby populations. ***The assessment follows commonly accepted industry standards including the recommendations of the Center for Chemical Process Safety (CCPS), and the Health and Safety Executive of the United Kingdom."***

But in Section 6.0 References, only one narrowly-focused UK HSE 2004 research report from an industry consultant ["Development of a method…" is grandiosely presented as an "industry standard", and the "recommendations of the US AIChE CCPS" are cited as originating in five quite dated CCPS Guidance documents from the Last Century, the most recent being from 1996.

CCPS typically asserts its scores of "Guidelines" series books are efforts to pull together current data and information on various chemical industry safety risk topics, and their publisher Wiley says they are written by teams of experts and peer reviewed, but intended to create only **"a foundation document for industry development and application" of e.g., risk tolerance criteria** ["Guidelines for Developing Quantitative Safety Risk Criteria" August 2009].

The CCPS books explicitly do not represent any formal industry standard and often show how corporations or facility management might utilize many various

kinds of methodologies for assessing and reducing risks without adopting any [as if CCPS as a voluntary membership organization could do so] as an industry standard, not even those adopted by American Petroleum Institute or the National Fire Protection Association or the American Association of Railroads [AAR] as voluntary consensus standards.

"CCPS has set the following Goals, as stated in the 1993 CCPS annual report:

- **Establish and publish the latest scientific and engineering <u>practices (not standards</u>)** for prevention and mitigation of incidents involving toxic and/or reactive materials
- Encourage the use of such information by dissemination through publications, seminars…"

[CCPS "Guidelines for Chemical Transportation Risk Analysis", 1995, no longer offered separately on CCPS website but which is augmented by the 2008 Guidelines book on transportation risks and available on that book's accompanying CD-ROM] [See Endnote 2]

B.

While CCPS has in recent years been a strong proponent of QRA methodologies for corporate and facility management risk assessment in both facilities and transportation sectors, **CCPS also has regularly <u>highlighted the limitations</u> of the techniques and specifically that <u>it has hardly been used at all in transportation</u>**. This is seen most explicitly in the earlier CCPS Guidelines, but there is no indication in the later volumes that the situation has improved markedly.

The earlier 1995 CCPS "Guidelines for Chemical Transportation Risk Analysis", [augmented only later by 2008 CCPS Guidelines for "Chemical Transportation Safety, Security, and Risk Management"]:

1. CCPS began its "Guidelines" series in 1985 focused on describing "qualitative tools for identifying, assessing and reducing process hazards." [p. xi] and it later focused most effort on Quantitative Risk Analysis [QRA] as with its 1989 Guidelines fixed chemical facilities.

Reflecting widespread public and official concerns, in 1995 it turned some attention to chemical transportation ["hazmat"], in its "Guidelines for Chemical Transportation Risk Analysis" [TRAs]. **The Preface clearly identifies three major approaches to measuring chemical risks: qualitative, semi-quantitative, and quantitative [p. xii], but emphasizes that it does not discuss how to evaluate the qualitative or quantitative risk results and how to determine if the risks are tolerable [to company management] or if improvements need to be made." Transportation risk estimates are only "one of the important pieces of data required to make decisions on management of the risks of hazardous materials transportation." [p. xii]**

2. The 1995 Guidance highlights early on [pp. 28-29] **some notable "limitations" of qualitative TRAs, but even more for quantitative TRAs. "[T]he major limitations of any TRA are related to uncertainty... Quantitative TRAs … have uncertainties that can span one or two or more orders of magnitude." [i.e., the risk results estimated can be 10 times greater, or 100 times or 1000 times higher or lower.] [see Benchmark Report discussion in Endnote 1]**

The TRA methodology itself [pp. 29, 31] is **in its infancy** regarding its use in the US:

"[N]o systematic requirements for TRA currently exist in the US for the chemical process industry. Various communities are using TRA approached to understand risk levels or help with route restrictions, but as yet there are no equivalents *to the risk management program requirements enacted by many states for fixed facilities" [more accurately, by a few states and nationally by the Clean Air Act Amendments of 1990, section 112 r and with US EPA implementing regulations.]* ***… [A] number of companies do conduct QRAs and a few have clear risk policies and targets… Only a very few large detailed studies have been published… but there is very little sharing of results…***

Where TRA is applied quantitatively, <u>there is no consensus at this time over the appropriate risks measure or measures to be used.</u>"

3. *"**The overall role of uncertainty** is very important to keep in mind, however, regardless of whether the TRA was qualitative or quantitative."* [p.34]

4. ***"Risk targets have been established by several governmental agencies and companies for in-plant risks; however there are very few such targets <u>for transportation risks</u>."*** [p. 34] Some are only "*proposed*" [emphasis in original] for use in the UK by an advisory committee in 1991.

5. ***"A few companies are starting to work with targets for transportation risks", but the potentials for risk reduction "can be difficult in transportation",*** **because of high costs** [p. 34]. [One potential cost might be for signal systems installed, which sometimes can reduce human error." [p. 66]

6. This CCPS Guidelines speaks directly to key data used in the RDEIR: rail accident reports and rail volumes by track class], in pointing to issues regarding "2.2.6 Confidence in Data" [pp. 72-74], for example: **"There is a high degree of uncertainty regarding the breakdown of railroad traffic volume (train and car-miles) by track class. Therefore <u>accident rates by track class are highly uncertain.</u>" "Many [railroad-supplied] reports of transportation releases are inadequate for risk assessment purposes."[p 113] .**

7. CCPS documents emphasize the role of researchers' key **engineering "judgments**" throughout the TRA process, e.g, for selection of possible spill scenarios [p. 118], ignition probabilities [p. 125] And key researcher **"assumptions"** are involved in calculating on-road populations and selection of route segmentation.[pp. 121-123], likelihood of an explosion [p.130], likelihood of a BLEVE [p. 136]

8. Ironically, given the complete pretense of regulation in the current US law that allows the railroads complete secrecy and flexibility in analyzing and selecting routes, the CCPS's case study of a Rail Risk Assessment [Section 7.3, pp. 273ff] focuses on using TRA as a way to select the least dangerous route for a chlorine tank car [only one in a train], so a company can use this "as one factor in considering which supplier to choose". CCPS mentions **no actual examples of any company using this kind of analysis.** Even if a few have been done, none is apparently available in the public domain. The QRA on routing "identified the significant contributors to [accident] risk", but CCPS says "[No company] decision is likely to be based on risk alone. Costs, reliability of supply,, and other factors will be important additional considerations."[p. 284]

C.

CCPS has been cautionary in highlighting the need to <u>reserve full-scale QRA for "the toughest" [corporate or facility] management decisions [not the same as political decisions]</u>:

In Chapter 5 of the CCPS "Guidelines on QRA" [2008] on QRA [pp. 71-72], CCPS states:

"[A]s is <u>common industry practice</u>, the escalation to a QRA should be used sparingly and only for <u>the toughest</u> risk management problems. Simpler techniques … should be exhausted… to the fullest extent. [Some reasons for a company management to commission a full QRA include when] :

- *Decisions cannot be made or there are unanswered questions/issues*

…

- *A cost-benefit analysis of the relative difference between options needs to be evaluated." [pp. 71-72]*

CCPS [p. 75] underscores that QRAs are so complex that they "need to be conducted by risk professionals with experience in the methodology, consequence analysis, frequency analysis and interpretation and presentation of risk results."

"The risk analyst is dealing with risk estimates, and … it is essential that the potential **extent of uncertainty or key assumptions that are a major influence on the risk results be known and understood."**

Sharp "questions should be asked about the data, its availability, suitability, level of confidence, how the results will be interpreted, are the data detailed enough to justify predicting the desired consequence levels (e.g., fatalities, injuries, evacuations, environmental, economic)?" [p. 77]

…"If only generic accident data are available,. Pick them carefully and ensure that they apply reasonably well to the situation being analyzed."[p. 78]… Consequences [of flammable releases] can include Vapor Cloud Explosion , BLEVEs, pool fire, jet fire, flash fire….[p. 81]

In section 3.1.4 Uncertainty [p. 91], **CCPS again highlights uncertainties: "SRA results are determined using various likelihood databases, consequence models onsite and offsite population data, and other assumptions. Each of these inputs has limited accuracy, therefore, there is uncertainty associated with risk assessment results… All inputs and assumptions should be documented. Risk estimates should not be treated as exact measurements, but as a best estimate of the risk level."**

"The greatest value [of QRA] is in providing a relative risk comparison (for the corporation, business, or operation) so that priorities for action can be set."

D.

The City asks the reader of the RDEIR to accept two major "Black Box" sets of calculations, in which key assumptions and calculation decisions are left unexamined, and in fact suspect, because they involve proprietary data unavailable in the public domain. One of the City's consultants, Marine Research Specialists [MRS], uses its own proprietary software for consequence analyses, SuperChems TM model [pp. 15-16]
http://www.ioiq.com/superchems/features.aspx
which may be quite adequate relative to other models, but is proprietary:

" ***A QRA computer model, developed by Marine Research Specialists,*** *is used to calculate the risk profiles and, in conjunction with Geographic Information System software, to manage the data in accordance with CCPS guidelines for hazard assessments (CCPS 1989)."*

And City consultant Professor Barkan employs an even more interesting [and un-transparent] analysis tool. **Barkan touts his use of a "unique combination" of FRA data and proprietary Class I freight railroad information** which include all freight rail traffic instead of looking for crude by rail accident data specifically [which are sparse]:

> ***"****APPENDIX A.1. Derailment Rate Analysis Database and Methodology The accident database used to develop the statistics for this risk analysis is comprised of* ***a unique combination of Federal Railroad Administration and proprietary Class 1 freight railroad information.*** *The data used to calculate the rates are not limited to trains shipping crude oil; instead they include traffic, infrastructure and accident data for all freight trains operating on U.S. Class 1 railroads. Proper estimation of train accident rates involves analysis of all reportable accidents, divided by the total amount of traffic. By accounting for specific physical and operational conditions where accidents occurred and the amount of rail traffic operating under these same conditions, more refined, accurate estimates of the derailment rate can be developed. The data and analytical method used provides a more robust, reliable database for estimating rail accidents and derailments than is possible using historical accident data for particular segments along an individual route. Following is a more detailed explanation of the data and methodology." [p. 13]*

The **RDEIR overtly overstates the validity of its models:**

"Performing state-of-the-art hazard assessment requires a combination of sophisticated analytical techniques and extensive professional experience. The consequence models used in this analysis are the result of more than two decades of development, and they have been validated using large-scale field

tests. While a large number of consequence models are available, only a few specific models were needed to assess the hazards identified as part of this study."

What this statement obscures is that an extensive search of relevant literature suggests that **none of these still-developing transportation risk models** have been used at all previously, much less "validated using large-scale field tests", **regarding serious multi-car releases for Crude Oil by Rail unit train cargoes**. **[See end note 3**] And according to the most prominent North American rail car explosion expert, Dr. A.M. Birk at Queens University in Canada, **there have been no studies [not published or in the public domain on the consequences of such accidents [personal phone conversation, 2014].**
http://me.queensu.ca/People/Birk/Research/ThermalHazards/bleve/

[The one exception is a small and narrow, but useful study done – using only liquid flow models, not explosion/fire impact models] on the released burning crude oil liquid flows at Lac-Mégantic in July 2013, the "Rivers of Fire" reported by survivors which accounted for the fire damage observed in aerial photos. See End Note 4.]

E. The RDEIR blithely ignores the **security issues** in CBR mainline rail transportation or in unloading facilities, even though this concern is completely mainstream in chemical industry and government circles.

See Endnote 2 below, citing the CCSB's 2008 Guidelines for Chemical Transportation Safety, Security, and Risk Management, 2nd Edition, which has a new 30-pp. chapter. As part of its list of chemical transportation risk topics for industry professionals CCPS now includes:

- ***"Discusses considerations for transportation security, including threat and vulnerability assessments and potential countermeasures***
- ***Summarizes key transportation security regulations, guidelines and industry initiatives."***

Two security-related comments seem most important:

a. The Benicia-area refineries could be attractive targets for terrorism, as surely a key sector of the US strategic infrastructure in energy resources. And the California routes to those refineries are likewise, and perhaps even more insecurable and vulnerable to potential terrorist attack.

b. Recent cases in California law [San Luis Obispo Mothers for Peace case] seem to indicate that a **demand that terrorism risks be considered in any serious DEIR process for a new high-risk facility** could be upheld as reasonable.
http://www.pillsburylaw.com/siteFiles/Publications/839E98B17AA3C8E45D0ADA74928D1108.pdf

END NOTES

1. European Commission Ispra/RISO Research Centers' 1989-2004 Benchmark research reports on Probabilistic Risk Assessment in chemical establishments:

http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.202.7900&rep=rep1&type=pdf Risø-R-1344(EN)
Assessment of Uncertainties in Risk Analysis of Chemical Establishments
The ASSURANCE project Final summary report
Kurt Lauridsen, Igor Kozine, Frank Markert Aniello Amendola, Michalis Christou, Monica Fiori May 2002
Authors are from major governmental risk agencies:
• Det Norske Veritas Limited, UK • INERIS, Fr • Health and Safety Executive, Major Hazards Assessment Unit, UK • NCSR DEMOKRITOS Systems Safety and Risk Assessment, GR • TNO, Dept. of Industrial Safety, NL • Università di Bologna, DICMA, IT • VTT Automation, FI • The Joint Research Centre, Ispra • Risø National Laboratory, DK

"Abstract This report summarises the results obtained in the ASSURANCE project (EU contract number ENV4-CT97-0627). Seven teams have performed risk analyses for the same chemical facility, an ammonia storage. The EC's Joint Research Centre at Ispra and Risø National Laboratory coordinated the exercise and led the comparison of results ***in order to reveal the causes for differences between the partners' results. The results of the project point to an increased awareness of the potential uncertainties in risk analyses and highlight a number of important sources of such uncertainties. In the hazard identification phase it was revealed that the ranking of hazardous scenarios by probabilistic and deterministic approaches could result in completely different conclusions****. On the other hand, despite a large difference in frequency assessments of the same hazardous scenarios, there was good consensus on the ranking among the adherents of the probabilistic approach. Breaking down the modelling of both frequency and consequence assessments into suitably small elements and conducting case studies allowed identifying root causes of uncertainty in the final risk assessments.* ***Large differences were found in both the frequency assessments and in the assessment of consequences. The report gives a qualitative assessment of the importance to the final calculated risk of uncertainties in assumptions made,*** *in the data and the calculation methods used. This assessment can serve as a guide to areas where, in particular, caution must be taken when performing risk analyses.*
…2 General notes on uncertainty in risk analysis Whereas Quantitative Risk Assessment (QRA) aims at the modelling of stochastic uncertainties associated with the occurrence and circumstances of a major accident, the process itself of carrying out a QRA is linked with several uncertainties. For the implementation of the risk assessment procedure a variety of techniques and models must be used, and uncertainties are introduced due to imperfect knowledge and expert judgement. As QRA is used as input in many decisions related to the control of major accident hazards and the need for accuracy in the results increases, the adequate management of these uncertainties gains increased importance. Risø-R-1344(EN) 5 An important source of differences in risk analysis is introduced by national philosophies underlying the analyst's effort. In addition, the application of different methods and methodologies will

contribute to the total uncertainty/variability of the final outcome of a risk analysis. *The complexity of establishing a model for the systems derives from the large number of different components, the control equipment used in modern processes and the interactions between all components and equipment, and the human operator. Further,* ***uncertainty is introduced by the physical modelling tools, as they treat e.g. release and dispersion phenomena, according to the relevant meteorological and environmental conditions.*** *Uncertainty is also connected to dose-consequences relationships. Finally, there* ***is uncertainty resulting from the various judgements of the analysts during a risk analysis. This is an unavoidable part of the process, and depends very much on the background and the operational field of the experts.*** *Other practical constraints (e.g. time and resources) may also result in* ***different degrees of simplifications, which in turn add to the variability of the results."***
http://aes.asia.edu.tw/Issues/AES2011/RoyPK2011.pdf
http://gnedenko-forum.org/Journal/2008/042008/RATA_4_2008-13.pdf
5-page report
http://www.hse.gov.uk/landuseplanning/hseriskanalysis.pdf
2004 Final Report

2. The most relevant and up-to-date CCPS Guidelines books the City consultants should have cited [as guidance documents only] regarding facility and chemical transportation risks would have been:

a. Guidelines for Chemical Transportation Safety, Security, and Risk Management, 2nd Edition
Published: August, 2008 ISBN: 978-0-471-78242-1 Pages: 166
http://www.aiche.org/ccps/publications/books/guidelines-chemical-transportation-safety-security-and-risk-management-2nd
"This CCPS Guideline book outlines current transportation risk analysis software programs and demonstrates several available risk assessment programs for land transport by rail, truck, and pipeline for consequences that may affect the public or the environment.

- *Provides introductory transport risk considerations for process engineers*
- *Gives guidance on route selection, equipment factors and materials*

- *Describes transportation security risk issues and industry practices to mitigate them*
- *Includes loading and unloading checklists for several transport modes*
- *Develops specific operating procedures and checklists to reduce human error*
- ***Discusses considerations for transportation security, including threat and vulnerability assessments and potential countermeasures***
- *Summarizes key transportation security regulations, guidelines and industry initiatives."*

b. Guidelines for Developing Quantitative Safety Risk Criteria [2008]
http://www.aiche.org/ccps/publications/books/guidelines-developing-quantitative-safety-risk-criteria
Published: August, 2009 ISBN: 978-0-470-26140-8 Pages: 211
Written by a committee of safety professionals, this book creates a foundation document for the development and application of risk tolerance criteria.

- *Helps safety managers evaluate the frequency, severity and consequence of human injury*
- *Includes **examples of risk tolerance criteria** used by NASA, Earthquake Response teams and the International Maritime Organization, amongst others*
- *Helps achieve consistency in risk-based decision-making*
- *Reduces potential liabilities in the use of quantitative risk tolerance criteria through reference to an industry guidance document*

3. On the **unprecedented and unanticipated CBR accident risks of recent unit train operations:**

"When you begin to look at [CBR unit train] cars that are derailing at speeds of 30, 40 miles an hour, it's very difficult, it's a big ask, to expect that a tank car get hit [and] not be breached," Karl Alexy, staff director of the Federal

Railroad Administration's Office of Safety, said in the April 22-23 2014 National Transportation Safety Board's Safety Forum on Rail Transportation of Crude Oil and Ethanol .
http://ntsb.capitolconnection.org/042314/ntsb_archive_flv.htm

Former FRA Administrator Joseph Szabo has publicly stated that the transcontinental unit train movement of crude oil from North Dakota and other places is a "game changer," requiring the agency to **rethink everything it has done and known in the past about rail safety.**

4. Proceedings of JRC2014 Joint Rail Conference
April 2-4, 2014, Colorado Springs, CO, USA
Lac Megantic Consequence study UIUC 2014
http://ict.uiuc.edu/railroad/articles/Files/Conference%20Proceedings/2014/JRC2014-3851.pdf
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