INF.22

Economic Commission for Europe

Inland Transport Committee

Working Party on the Transport of Dangerous Goods

Joint Meeting of Experts on the Regulations annexed to the European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN) (ADN Safety Committee)

Fortieth session
Geneva, 22-26 August 2022
Item 7 of the provisional agenda
Any other business

24 August 2022

English

ADN 9.3.4 revision results

Submitted by TNO, Netherlands Organisation for Applied Scientific Research

ADN 9.3.4 REVISION
RESULTS

Source: Schuttevaer (2009)

REVISION ADN 9.3.4

FINDINGS OUTLINE

1. Objectives of project
2. Collision energy statistics update
3. Revision crashworthiness calculations
4. Effect distances versus increased tank sizes
5. Conclusions and recommendations
6. Acknowledgements

OBJECTIVES

REVISION ADN 9.3.4

1. Update energy statistics
2. Explore feasibility increasing 1000 m^3 limit
3. Updating and extending guidance crash calculations

COLLISION ENERGY STATISTICS

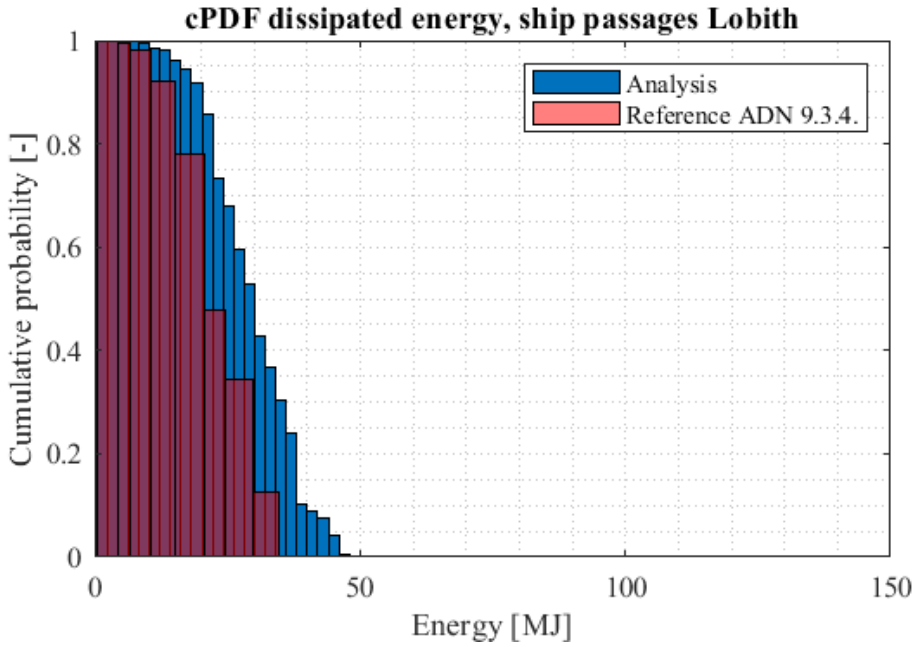
2005 VS 2017

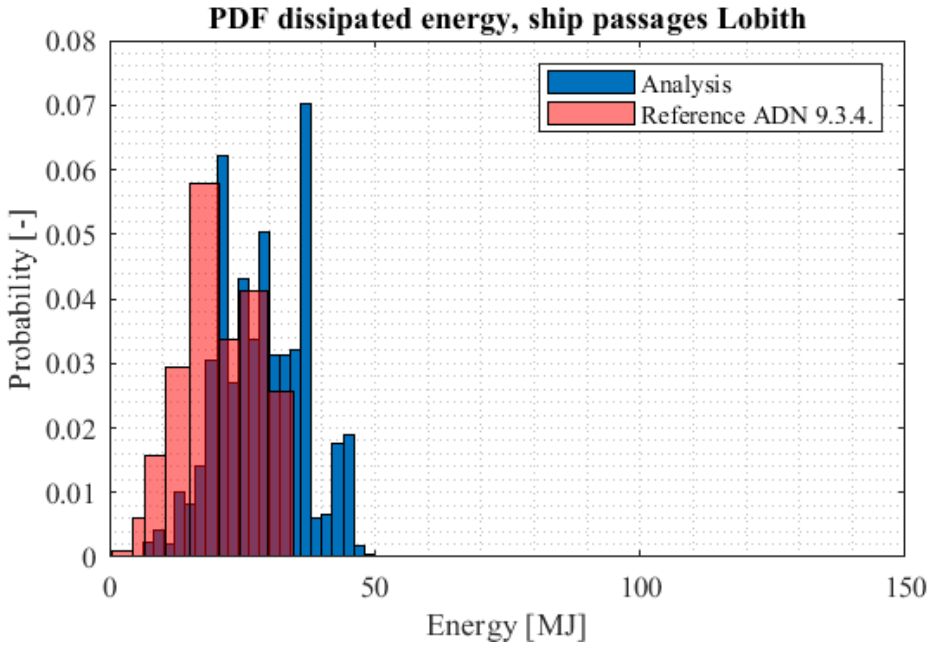
- Maximum velocity per CEMT class
  - Source BAW (2016)
  - Instead of total average of 14 knts

	ADN 9.3.4. (2005)	Present analysis (2021)
Speed of striking vessel	90% of trial speed (between 19 km/h [smaller vessels] and 14 km/h [larger vessels])	Maximum velocity per vessel type
Mass of striking vessel	Assume always fully loaded	Actual loading level from observed drafts
Mass bins	Based on rough DWT classes (6x)	Can be tuned: now per approx. 500 tonnes
Year of traffic data	1999	2017

COLLISION ENERGY STATISTICS

2005 VS 2021 ANALYSIS

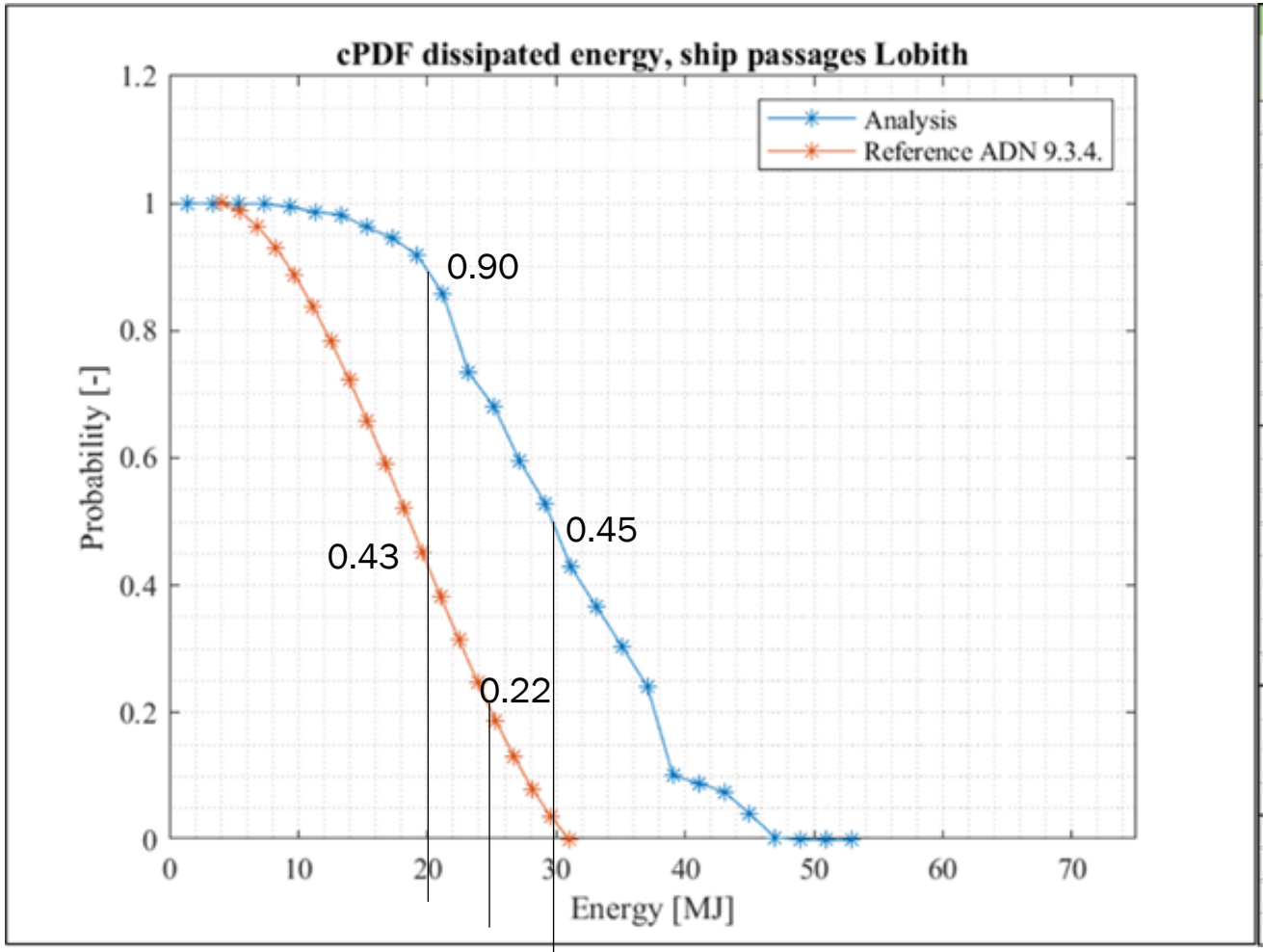




COLLISION ENERGY STATISTICS

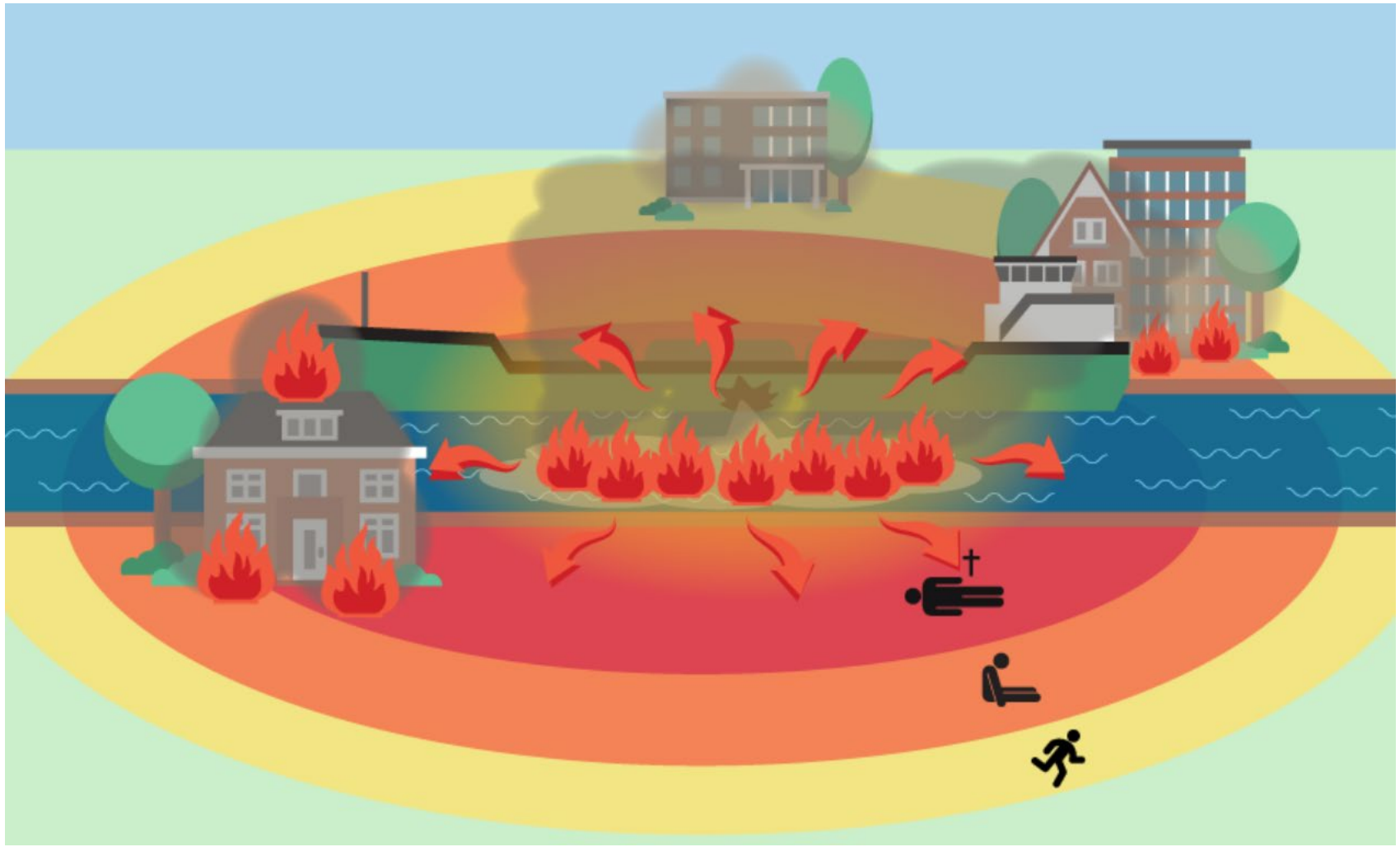
2005 VS 2021 ANALYSIS

- Example 8000t struck vessel (full speed scenarios)
- *Assume*
  1. ref. design absorbs 20 MJ,
  2. tank size 380 -> 760
- *Req. increase*
  CURRENT
  20 -> 25 MJ
  UPDATED
  20 -> 30 MJ



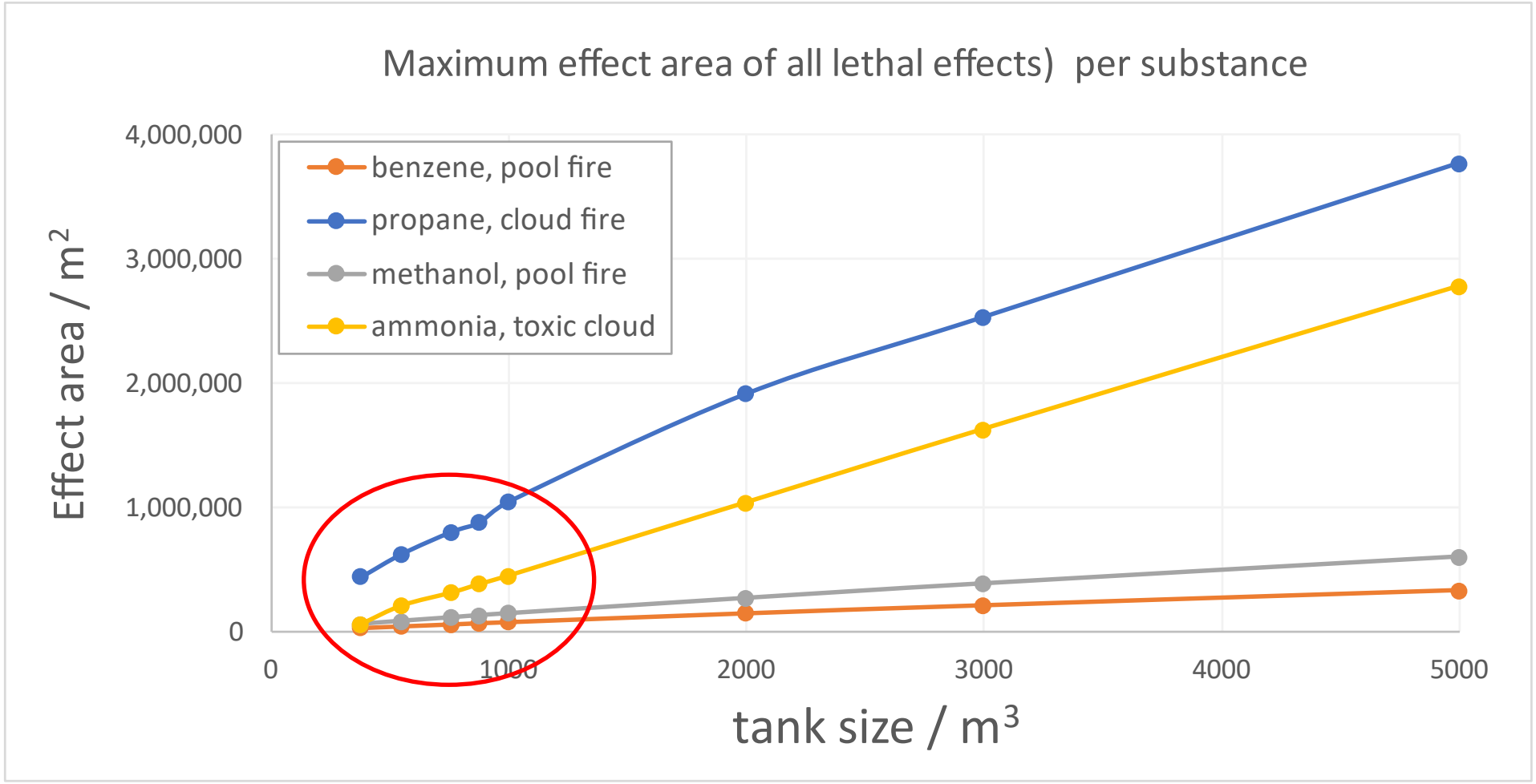
8000 tonnes	
E coll [MJ]	CPDF [ ]
3.39	1.000
5.37	0.999
7.35	0.999
9.34	0.995
11.32	0.986
13.30	0.982
15.28	0.962
17.26	0.946
19.25	0.918
21.23	0.858
23.21	0.734
25.19	0.680
27.17	0.595
29.16	0.529
31.14	0.429
33.12	0.367
35.10	0.305
37.09	0.241
39.07	0.102
41.05	0.089
43.03	0.076
45.01	0.041
47.00	0.004
48.98	0.001
50.96	0.000
52.94	0.000

MAX. TANK SIZE 1000 M³



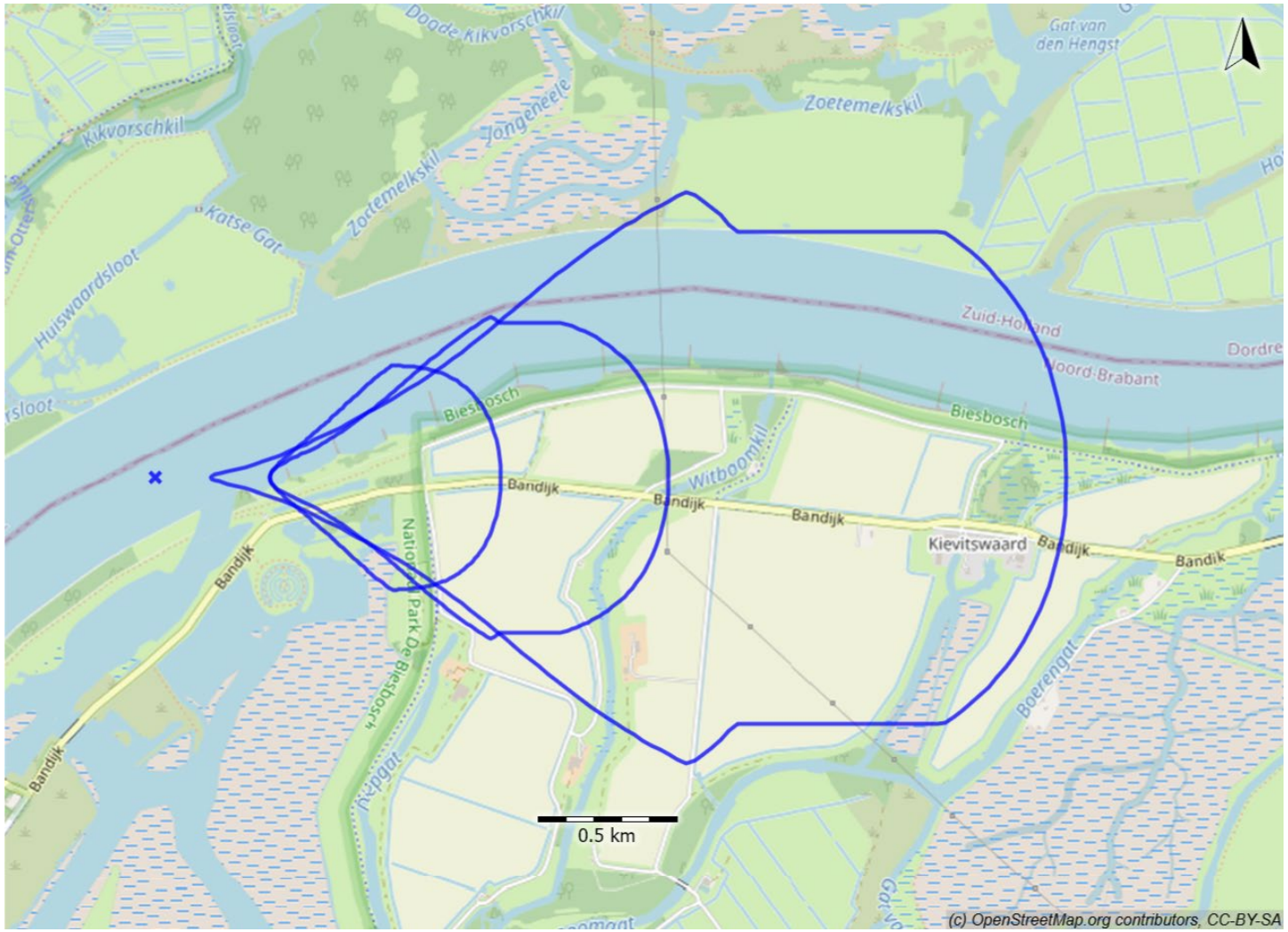
MAX. TANK SIZE 1000 M³

EFFECT AREA RATIOS VS TANK SIZE



MAX. TANK SIZE 1000 M³

PROPANE 380, 1000, 5000 M³; CLOUD FIRE; 1% LETHALITY CONTOURS



REVISION CRASHWORTHINESS CALCULATIONS

OVERVIEW

- Goal: Determination of the collision energy absorbing capacity

Update:

- Failure criteria
- Impact location
- Influence of element size
- Friction

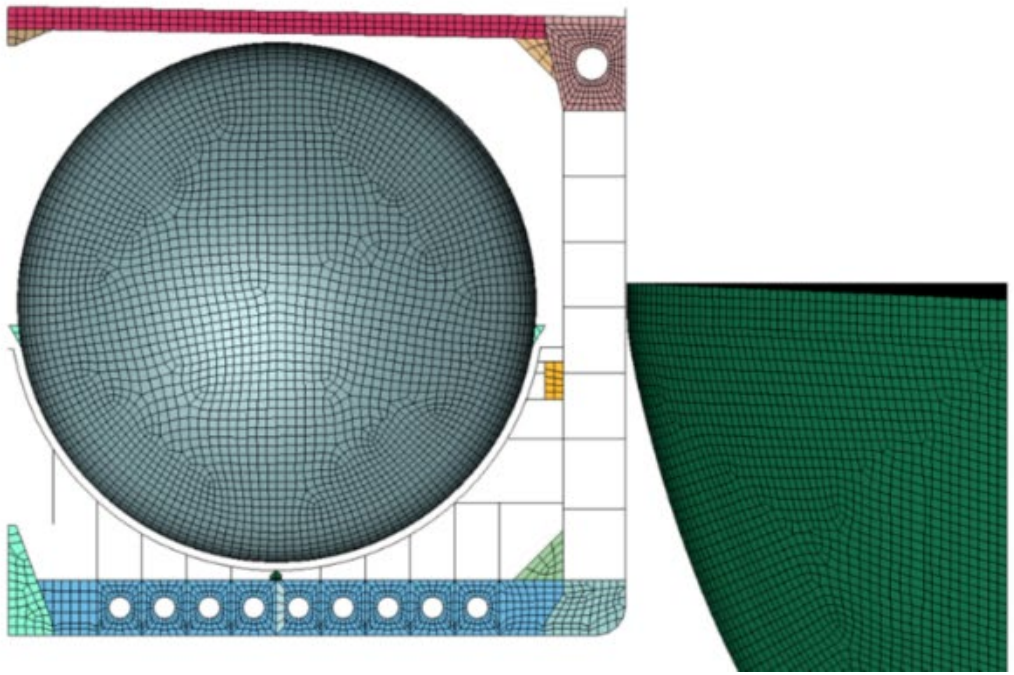
New:

- Internal tank pressure
- Material data for other materials (stainless steel, cryogenic)
- Failure mode

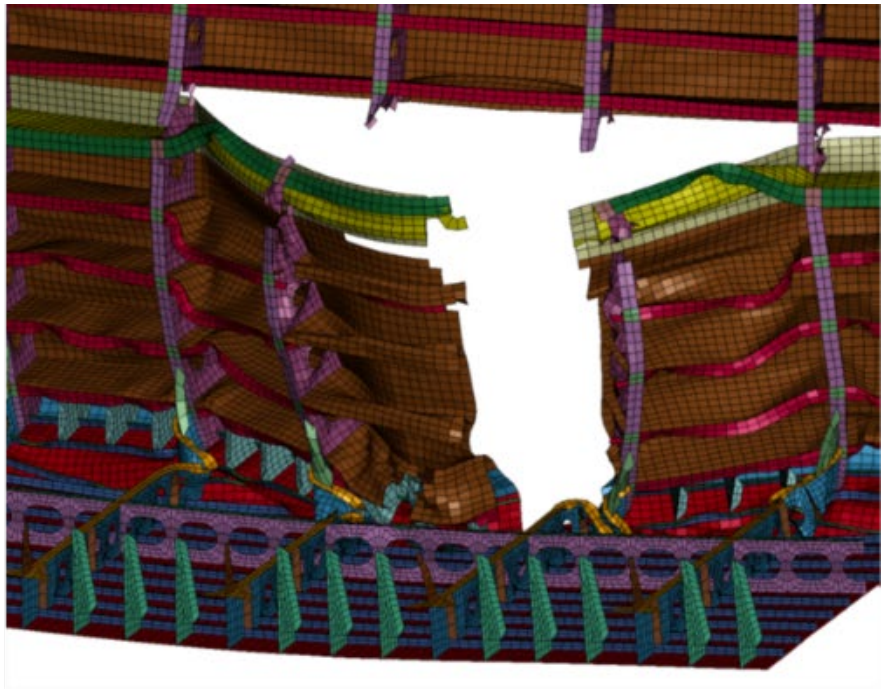
REVISION CRASHWORTHINESS CALCULATIONS

EXAMPLE IMPACT LOCATION

cross section



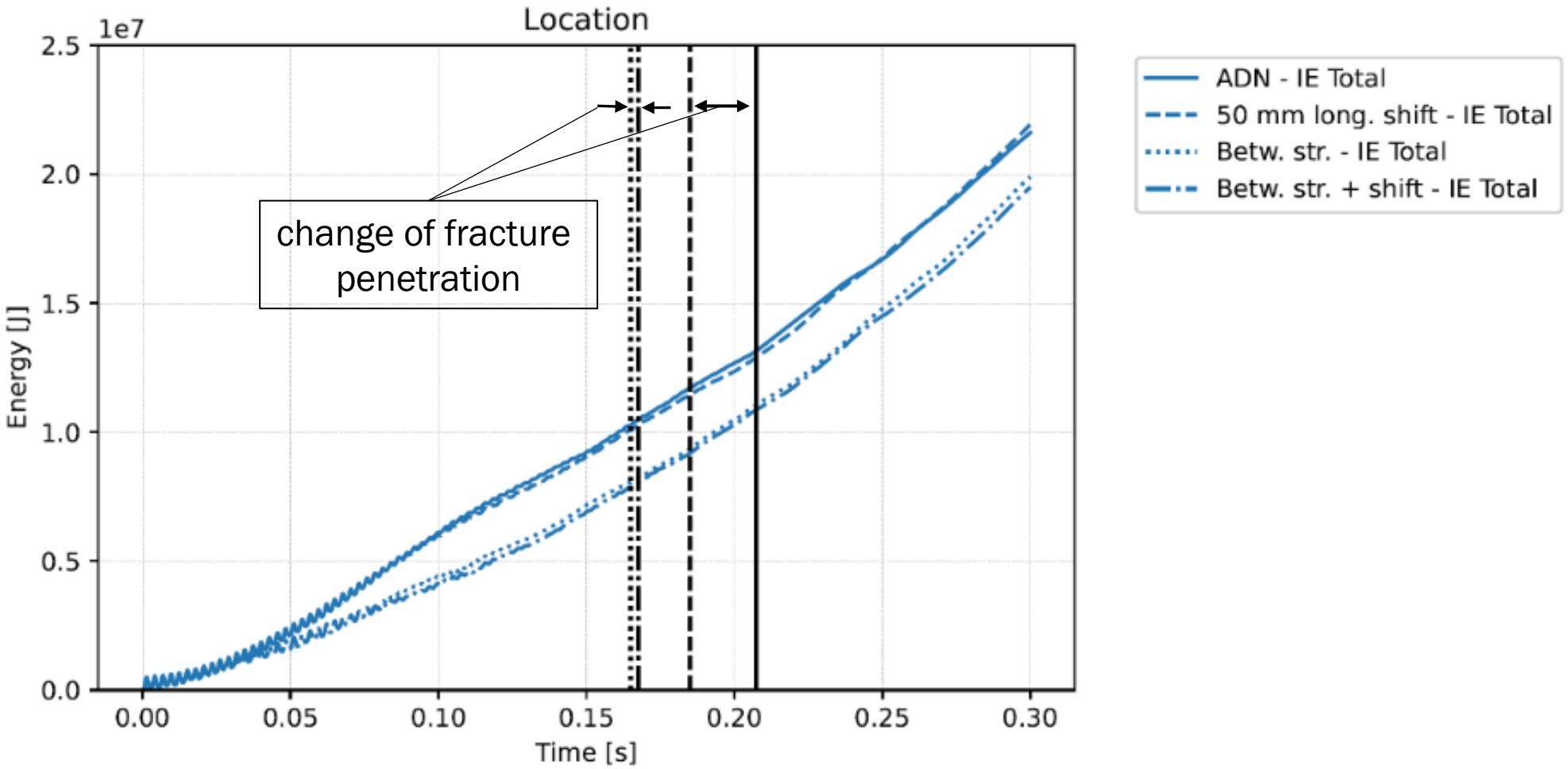
calculated damage



- Long. shift 50 mm
- Vert. shift ½ stringer spacing

REVISION CRASHWORTHINESS CALCULATIONS

EXAMPLE STRIKING LOCATION

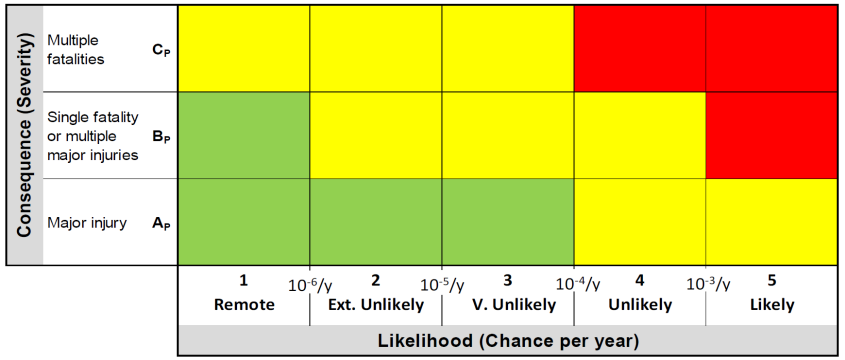


CONCLUSIONS RECOMMENDATIONS

EXTRACT

Collision energies

- Update collision energy statistics
- Tables instead of formulas



1000 m³ limit

- Keep in place
- Investigate derogations for specific cargos, e.g LNG, LH2 and CH2 based on QRA

Crash calculations

- Correct typos, especially on friction
- Rephrase ambiguous formulation, GL criterion
- Type G prescribe additional collision hight, i.e. between stringers
- Separate energy calculation and tank failure calculation

ACKNOWLEDGEMENTS

CASH AND IN-KIND

Partner	Role (all partners: input from practice)
TNO	Sponsor, analyses, reporting and PM
Somtrans	Sponsor
Rensen Driessen	Sponsor
Mercurius	Sponsor
Oudcomb	Sponsor
Victrol	Sponsor
GTT	Sponsor and design input
Damen Naval	Analyses
Femto	Analyses
Annmar	Analyses
LR	Review and support guideline
BV	Review and support guideline
Shell Shipping & Maritime	Analyses