CHEF implementation @ dsm-firmenich

Dispersion/explosion effect distance calculations

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Introduction

Pier-Jan Hettema

- Chemical Engineer – TU Eindhoven – Netherlands
- 14 years operations – Dupont, Shin-Etsu
- 5+ year consultant in Reliability Engineering and Process Safety
- 10 years Process Safety Expert – ADM, dsm-firmenich

- EPSC Board member since 2021

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Innovators in nutrition, health and beauty

Perfumery
& Beauty

Taste, Texture
& Health

Health, Nutrition
& Care

Animal Nutrition
& Health

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Three dynamic markets, two iconic names, one foundational purpose

dsm-firmenich: we bring progress to life

We're a trusted partner to global companies operating in high-growth and resilient markets. We're innovators in nutrition, health, and beauty

~30,000

passionate, talented, and diverse people in our global team

150+ years

of combined scientific discovery and innovation heritage

€12+ bn

combined revenue

History of CHEF tool @ dsm-firmenich

CHEF Calculation Aid
Chemical Hazard Engineering Fundamentals

- Ken First retires at DOW – RAST is donated to EPSC and CCPS
- 2017 RAST introduction into EPSC
- EPSC work group (Dow, BASF, Dupont, DSM, …)
- Aware of CHEF -> same formulas but simplified -> better fit

- Focus on CHEF as supporting tool
- Internal training in technical background and use of CHEF
- Mandatory now for HAZOP and OBRA scenarios

The tool

Excel V4.3 via CCPS →

Home / Risk Analysis Screening Tool (RAST) and Chemical Hazard Engineering Fundamentals (CHEF)

RAST Manual and CHEF Aid

Last updated February 15, 2023

The Following Manuals are Available for RAST Users:

- RAST USER MANUAL V4.2
- RAST USER MANUAL (CHINESE)
- CHEF CALCULATION AID V4.3

Questions? Please contact us with questions, comments, or suggestions about RAST.

RAST User Manual V4.2
CHEF Calculation Aid V4.3

← Download and Install up Frequently Asked Questions (FAQs) →

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CHEF Guide

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Models

Source models

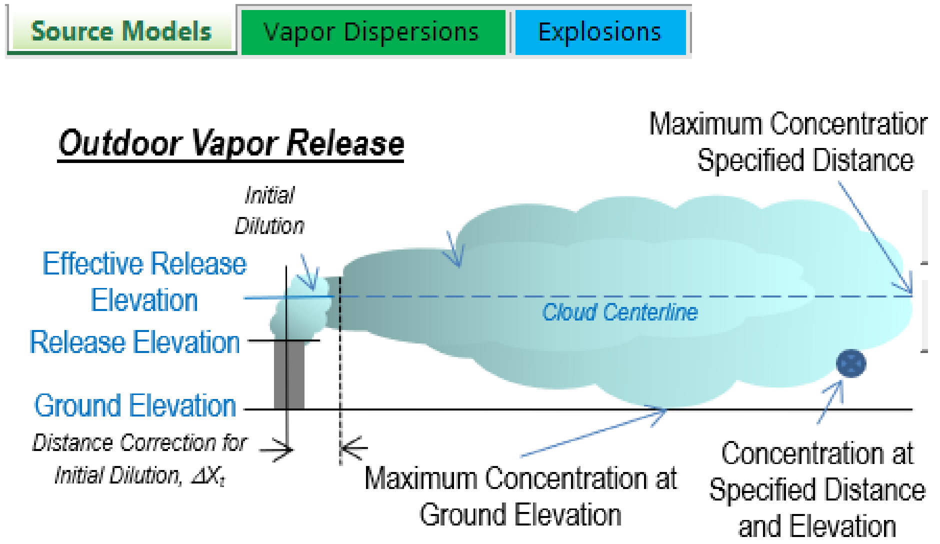
- Airborne quantity: hole size, flow rate, etc.

Dispersions

- Outdoor: 3D and 1,5F weather models
- Indoor: Volume, air exchange rate

Explosions

- VCE, headspace explosion: BST model (Baker-Strehlow-Tang)
- Physical explosion, condensed phase: simple TNT model



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Dsm-firmenich Threshold Limits

- **<u>Flash (or Jet) Fire</u>**
  *Exposure to flammable cloud of concentration > **0.5 * LEL***

- **<u>Building or Headspace Explosion</u>**
  *Indoor/inside average concentration exceeds **LEL**, else flashfire/fire ball*

- **<u>(Physical) Explosion</u>**
  *Direct Blast Impact for humans: > **2.5 psi (200 mbar)** overpressure*
  *Building Impact: > **0.5 psi (30 mbar)** overpressure*

  *Vapor cloud explosion: Larger LOPC's in combination with (**medium or high**) congestion of the area.*

- **<u>Toxic Vapor Release (Indoor, Outdoor)</u>**
  - *On-site exposure to > **ERPG-3** concentration (> 2 * ERPG-3 @ an occupied building).*
  - *On-site exposure to a toxic vapor cloud > **5 * ERPG-3** concentration (direct ops personnel)*

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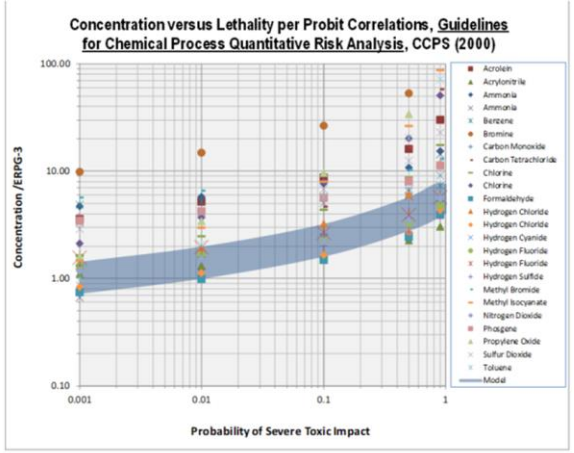
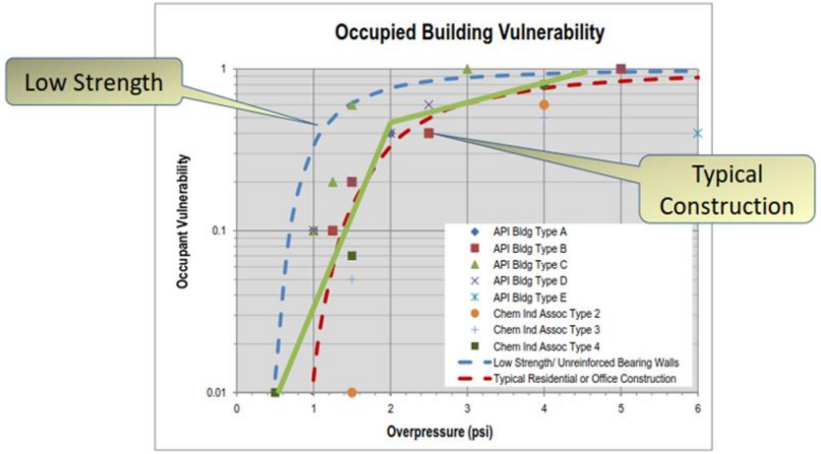
Affected number of people

People affected = Occupancy x vulnerability factor

explosion pressure @ human
200 mbar = 0 %
500 mbar = 100%
explosion pressure @ building
30 mbar = 0 %
300 mbar = 100%
toxic concentration
ERPG-3 = 0%
5 times ERPG-3 = 100%





CHEF Training

CHEF effect distance calculation tool - CHEF effect distance calculation tool

DASHBOARD | PATH | PEOPLE | SHARE

CHEF Introduction

- Introduction — Editorial | 5 min — 5 PTS
- CHEF Introdution Video — Video | 20 min — 20 PTS
- Self-study CHEF manual — Editorial | 60 min — 60 PTS
- Submit Questions — Assignment | 10 min — 10 PTS
- Knowledge Test — Assignment | 15 min — 15 PTS
- CHEF cases and submit results — Assignment | 30 min — 30 PTS
- Group session in TEAMS — Teams activity | 60 h — 60 PTS

CHEF Toxicity

CHEF source models (airborne quantity)

CHEF dispersion modelling

CHEF explosions

Introduction

167 learners

98% (164) completed

2% (3) not started

164 learner views

Welcome to the CHEF web-based training.

Objective of this training is to enable you to use the CHEF tool for calculating effect distances for fire, explosion, and toxic scenarios. Estimated workload for this introduction is 2 hours, depending on your basic knowledge.

In this introduction module you will learn the basics of using the CHEF tool. It starts with an introduction video and self-study of part of the CHEF manual.

The CHEF tool and manual can be found via the PS portal.

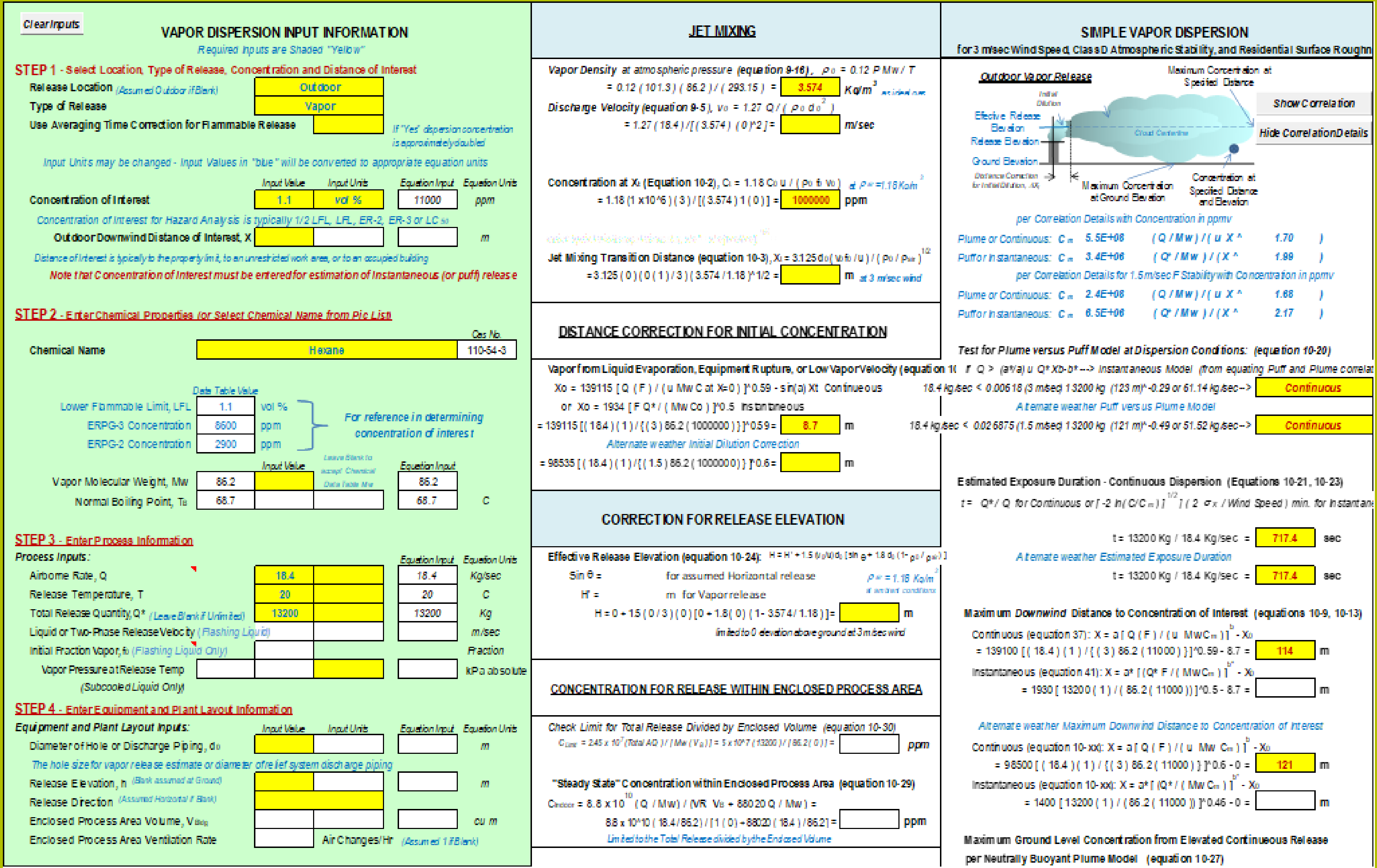
If you have questions about the content, you can submit your questions for an answer/discussion during the group session at the end of this module. This can be done in the "Submit questions" tab in the left menu. This module is all about starting to use CHEF, please keep in-depth questions about fire, explosion, and toxic scenarios for the upcoming modules.

After finishing all activities in this module (except the group session), you will receive an invitation to join a group session for discussion of your questions and the results of the CHEF cases.

Note: to download the CHEF tool, go to the PS portal OBRA section and open the tool in the Excel desktop app (not in SharePoint) and then save it to your computer. In this way you will keep all the macros. If you see the upper left 'clear inputs' button then you did it right.

NEXT

Demo



CHEF tool

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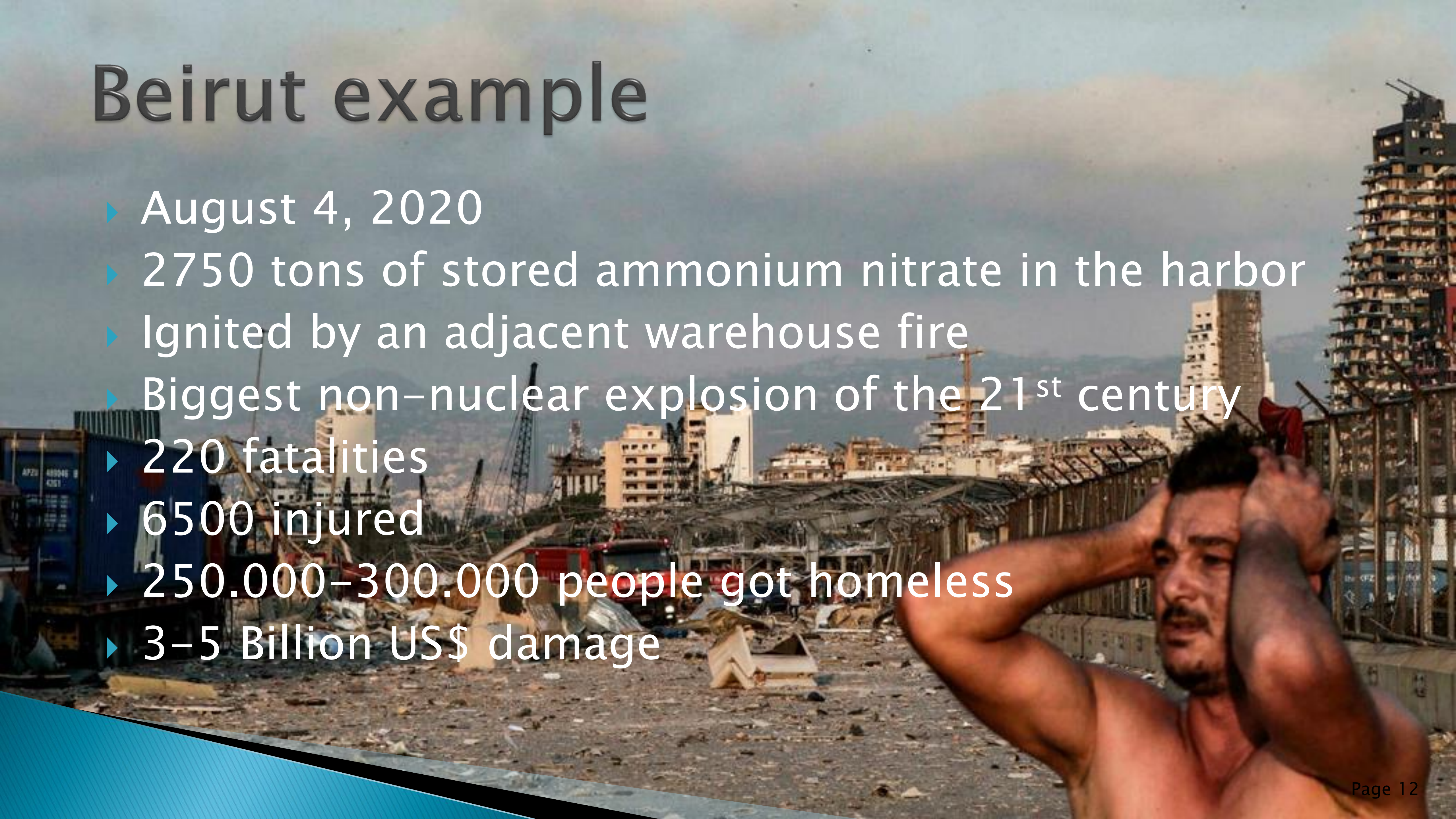
Beirut example



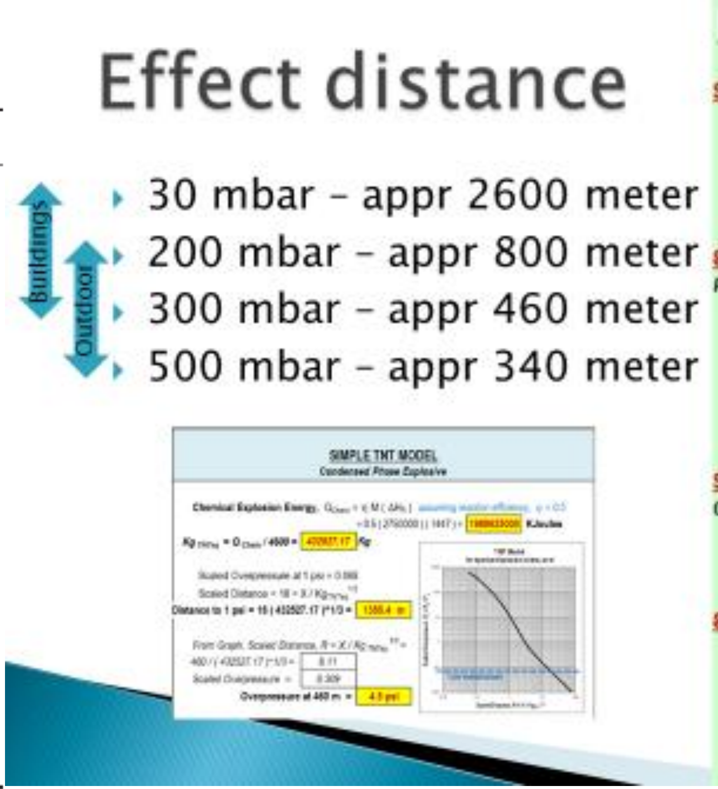
- August 4, 2020
- 2750 tons of stored ammonium nitrate in the harbor
- Ignited by an adjacent warehouse fire
- Biggest non-nuclear explosion of the 21st century
- 220 fatalities
- 6500 injured
- 250.000-300.000 people got homeless
- 3-5 Billion US$ damage

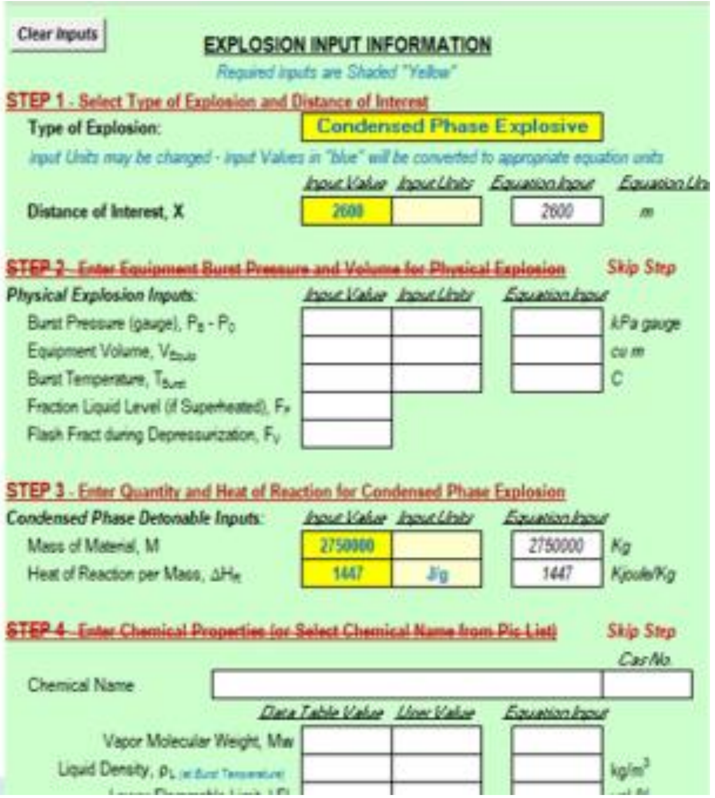
Ammonium nitrate

Thermal Decomposition of Ammonium Nitrate

Table 1. Properties of AN

Property	Property value
Molecular formula	NH_4NO_3
Molecular weight	80
Heat of combustion	1,447.7 J/g
Heat of formation	4,594 J/g
Heat of explosion	1,447.7 J/g
Heat of fusion	76.7 J/g
Density	1.725 g/cm^3
Color	Colorless
Melting point	169.6°C
Specific volume	0.580 cm^3/g
Solubility in water at 20°C	66 g/100 g
Oxygen content	60%
Available oxygen	20%
Estimated flame temperature	1500°C
Detonation velocity	1,250–4,650 m/s
Coefficient of thermal expansion at 20°C	9.82 × 10^{-4}%/°C
Specific heat from 0 to 31°C	1.72 J/mol
Vapor pressure at 205°C	7.4 mmHg

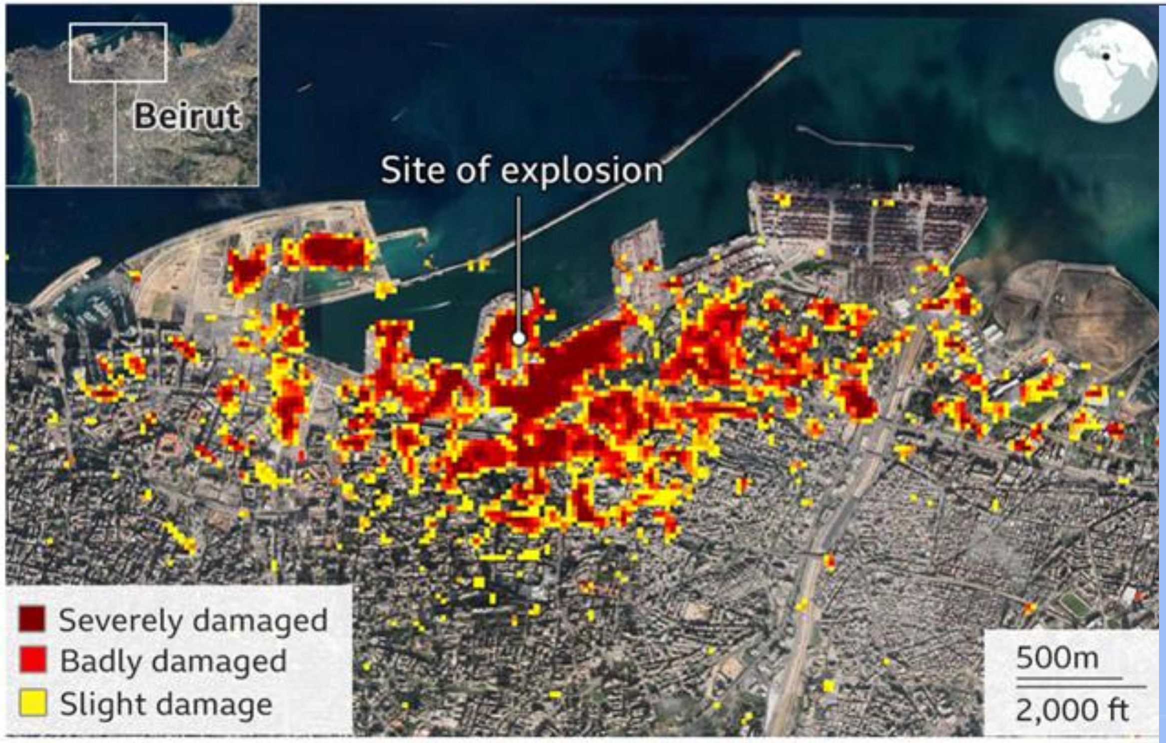




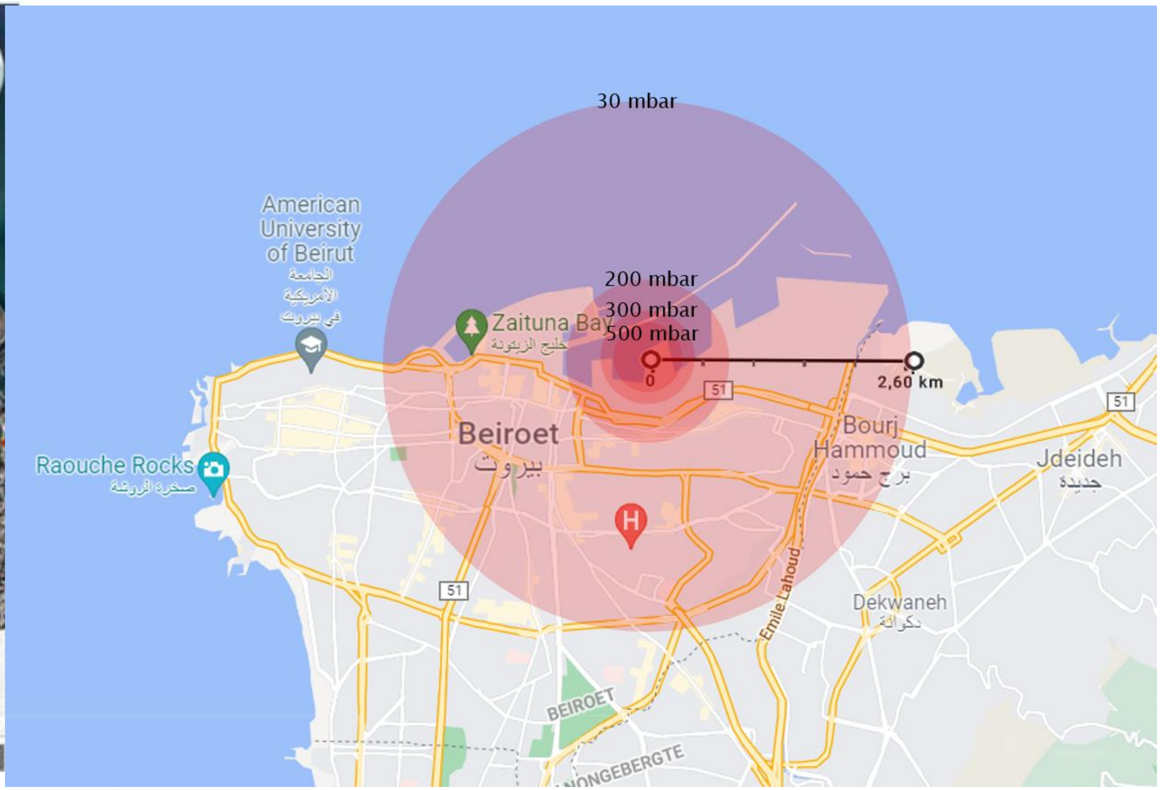
Reference: https://www.researchgate.net/publication/263578419_Review_on_Thermal_Decomposition_of_Ammonium_Nitrate

Area assessment

Beirut blast damage
Damage assessment carried out 7 Aug



Source: ASA/JPL-Caltech/Earth Observatory of Singapore/ESA



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