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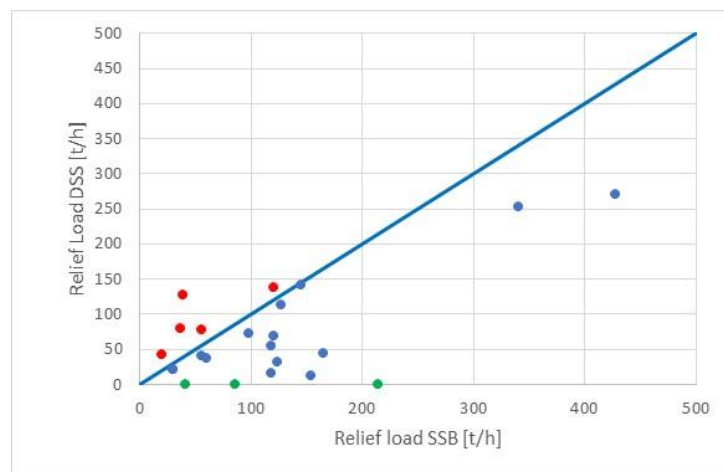**Relief Flare Analysis using a Dynamic Simulation of your Plant**

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12 June, 2023

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01 Introduction

When it is necessary to reevaluate the capacity of a site's existing flare system, industry often goes to a CAPEX solution because it applies a traditional methodology which requires a conservative approach to guarantee the safety of the system

02 API 521 01/2007 (Chapter 5.22)

Despite that API 521 statement in 2007, 16 years later SSB methods are the widespread approach applied by engineering companies while dynamic simulation is only reserved for "special cases"

03 Why is dynamic simulation reserved only for special cases?

- SSB Conventional methods are believed to be conservative
- Dynamic Simulation is thought to require a significant effort

04 Can we sustain that reliefs calculated by SSB are always conservative?

From the results shown in the presentation it can be affirmed that there is a 20% chance of a pressure relief valve area being under-sized and, therefore, that they cannot always be considered conservative.

05 How much is the effort required to perform a Dynamic Model of your Unit?

- Skilled Team of experts reduce the complexity of the models
- Digital Disruption could save the effort of building the models
- improvements in hardware technology

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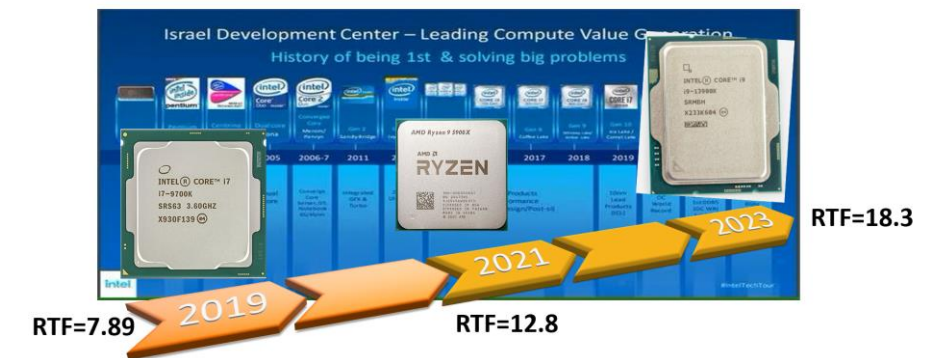
- There are various situations in which it is necessary to reevaluate the capacity of a site's existing flare system
- There is only one solution when the capacity of the site's flare system is reaching its limit: a capital project to increase it
- Conventional engineering approach for calculating the reliefs from units to the flare systems is based on Steady State assumptions while the relief load to the flare during an emergency scenario is basically a highly transient behavior
- The conclusion is that industry often goes to a CAPEX solution because it applies a traditional methodology which requires a conservative approach to guarantee the safety of the system

"Dynamic simulation can be used in pressure-relief system design to calculate transient pressure increases as indicated in 5.19 or to calculate required relief rates from individual pressure-relief devices. Conventional methods for calculating relief loads are generally conservative and can lead to overly sized relief- and flare system designs. **Dynamic simulation provides an alternative method to better define the relief load and improves the understanding of what happens during relief**."

Pressure-relieving and Depressuring Systems

ANSI/API STANDARD 521
FIFTH EDITION, JANUARY 2007

$$Relief\ flow = \frac{Unbalanced\ heating\ duty}{Latent\ heat\ of\ Vaporization}$$

2007 → 2023

despite that API 521 statement in 2007, 16 years later SSB methods are the widespread approach applied by engineering companies while dynamic simulation is only reserved for "special cases",

Question 1: In terms of relief calculations: A rough relief calculation is acceptable if it produces relief loads:

A) 1 to 1.1 times the actual relief load (12.9%)
B) 1 to 1.5 times the actual relief load. (35.5%)
C) 1 to 2.5 times the actual relief load. (41.9%)
D) 1 to 10 times the actual relief load. (6.5%)
E) 0.25 to 100 times the actual relief load (any number really is acceptable). (3.2%)

RIP Steady-State-Based Relief Calculations, Dynamic Simulation is the New Standard

Mo Abouelhassan · Follow
Published in Dynamic-Relief ePublication · 8 min read · Nov 6, 2022

https://medium.com/dynamic-relief/rip-steady-state-based-relief-calculations-dynamic-simulation-is-the-new-standard-49734ccc3e58

1. **SSB Conventional methods are believed to be conservative, oversizing the relief system, which is acceptable for the industry.**

2. **Dynamic Simulation is thought to require a significant effort and therefore make difficult to manage deliverables on time and on budget.**
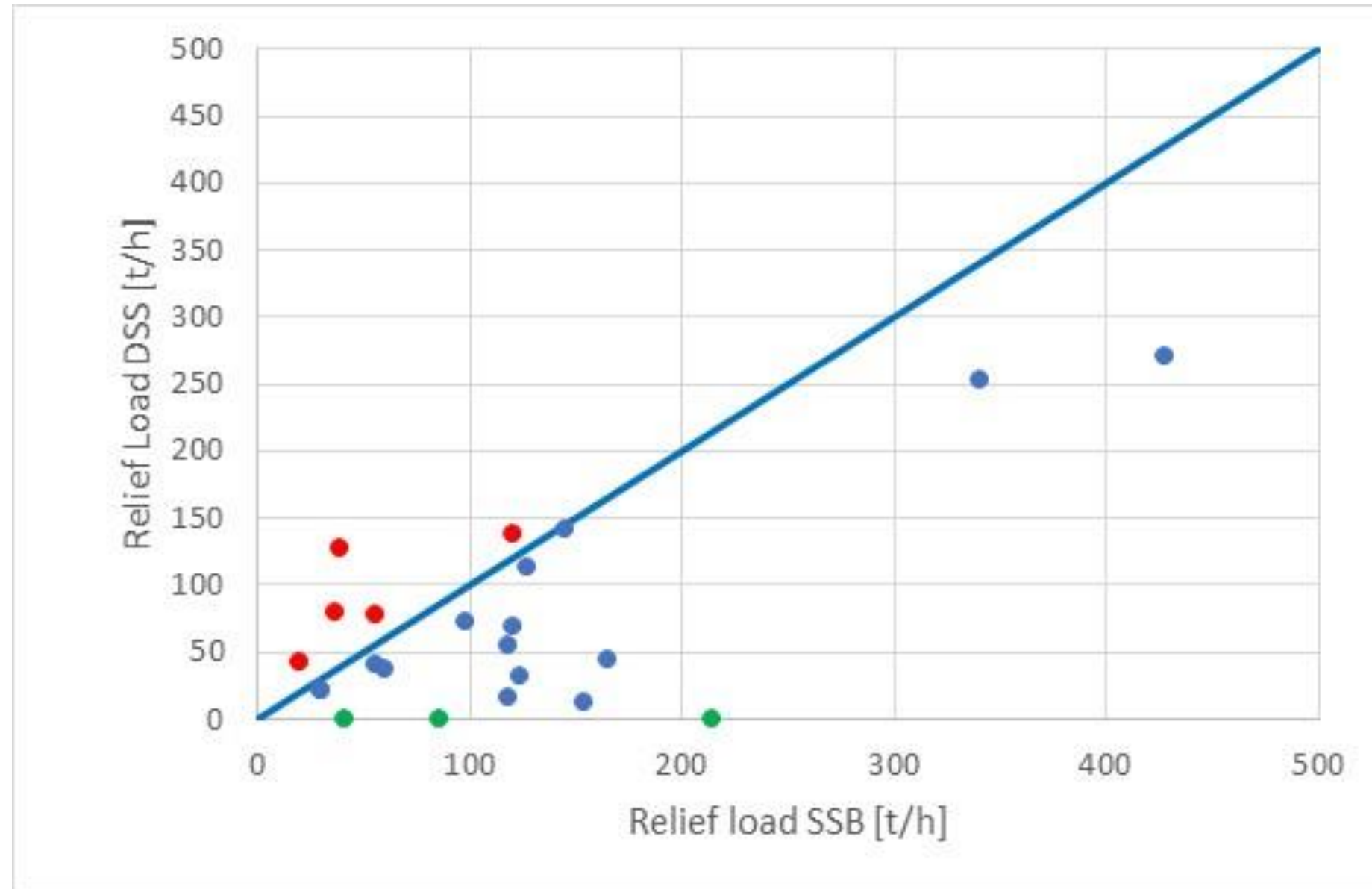
Figure shows a comparison of the predicted load by a SSB method versus the one predicted by the DSS for the same unit and scenario.
Data are a mixture from projects executed by Inprocess and other found in the literature.

A. Arbo (2008), P.L: Nezami (2008), D. Grubber (2010), Marchetti (2011), H. Chittibabu (2010), Harry Z. (2014) and M.H. Marchetti (2011).

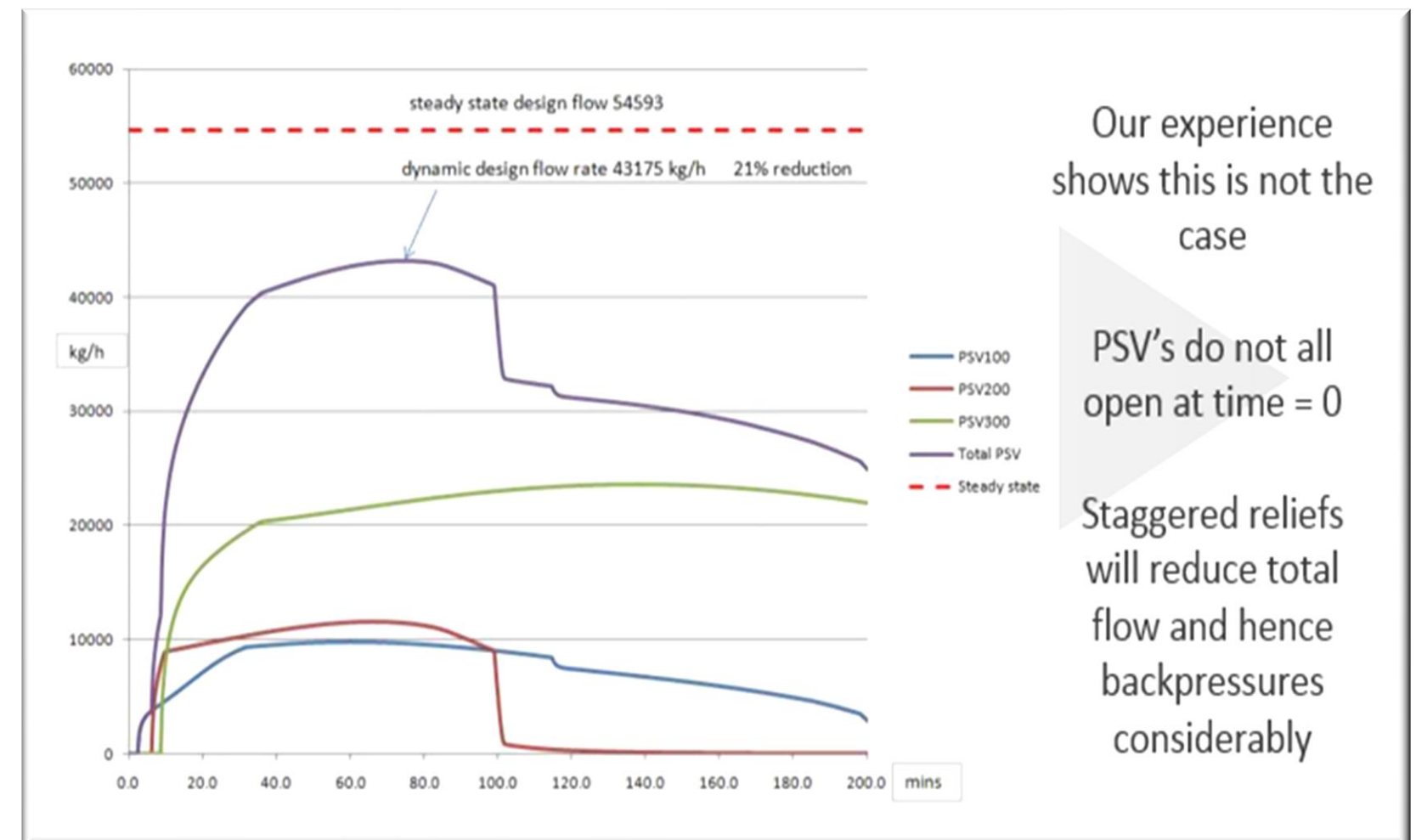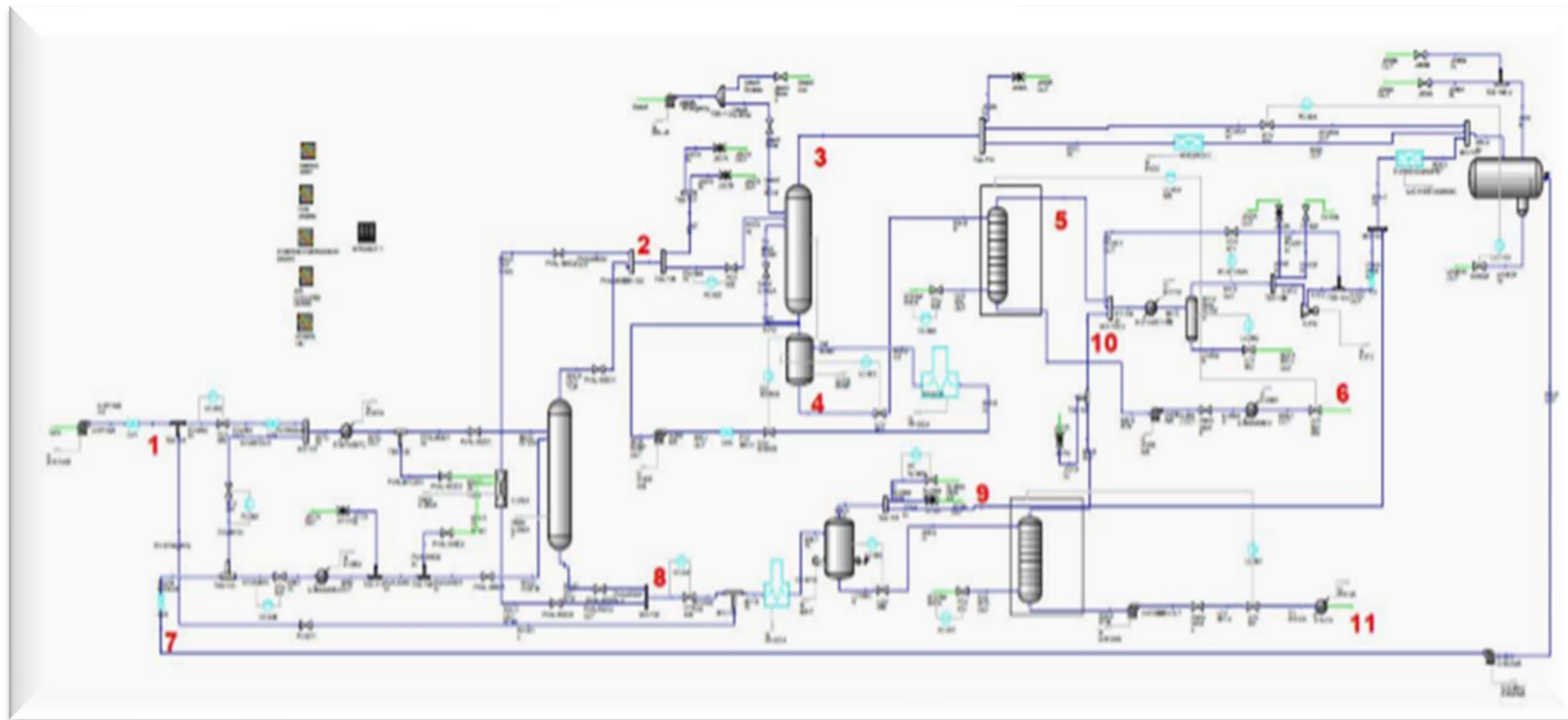1. **The process composition and flow changing during the transient**
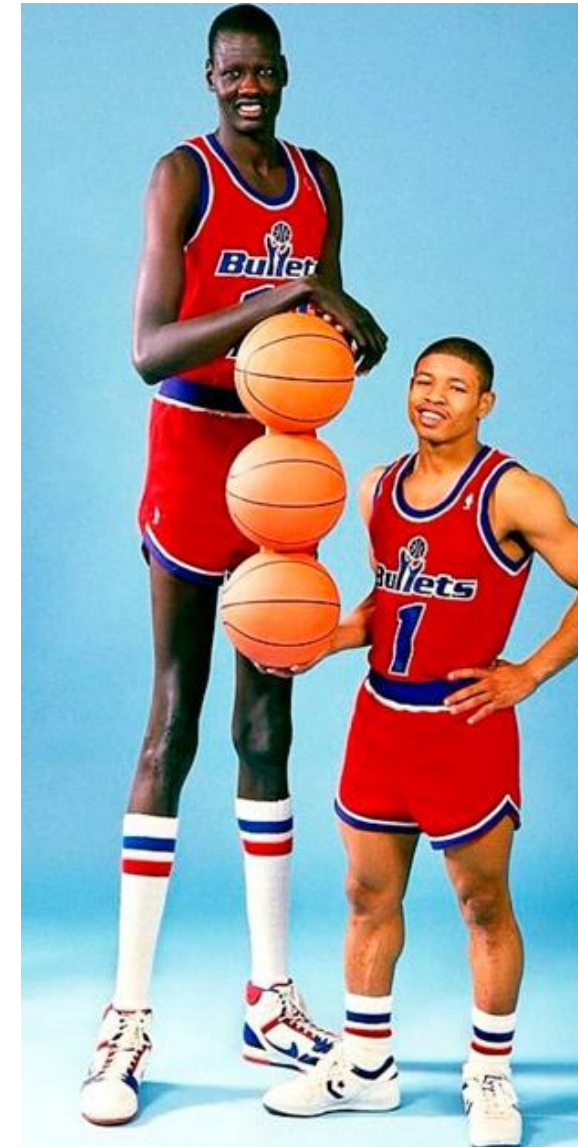
2. **The size of the equipment (hydraulics, process gain and time response)**

$$Relief\ flow = \frac{Unbalanced\ heating\ duty}{Latent\ heat\ of\ Vaporization}$$

SSB methods does not consider any of the two factors

Unlike the SSB, dynamic models could successfully include all the aspects that occur during a relief scenario and provide a rigorous calculation of the relief load.

Our experience shows this is not the case

PSV's do not all open at time = 0

Staggered reliefs will reduce total flow and hence backpressures considerably

Relief reliable estimation with the minimum effort is requires a **team of skilled experts**
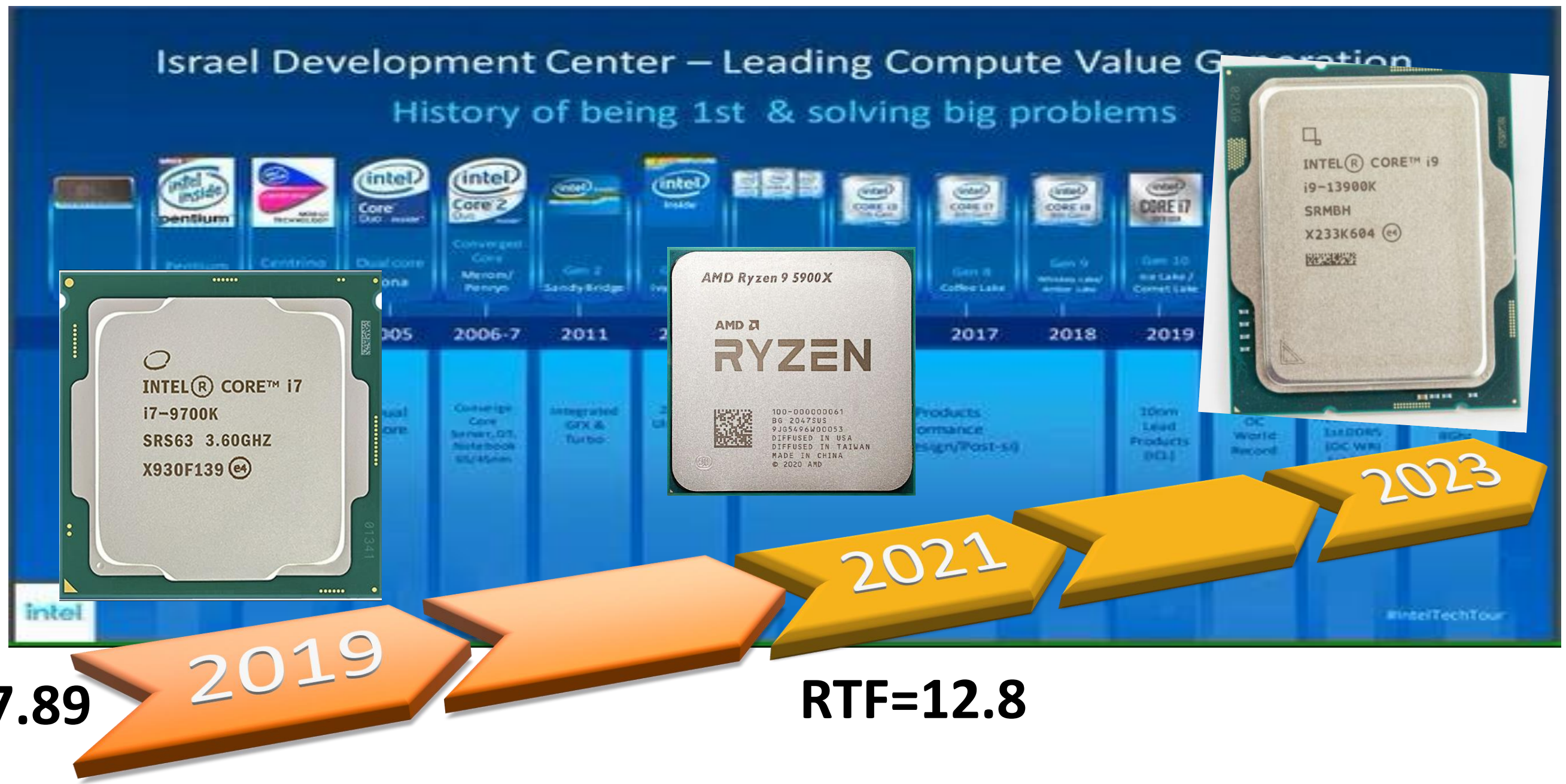- Plant operators
- Operator engineers
- Dynamic simulation experts

Digital Disruption into the Chemical Engineering Industry
- OTS based on First principles
- Digital Twins based on Dynamic Models

With previous verification of adequacy, these models already are available, saving all the effort invested on building the dynamic model itself.

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Thank you!

Any question?