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4<sup>th</sup> International Conference "Innovative and Safe  
Cooperation in the Barents Euro-Arctic Region,  
Petrozavodsk, May 23, 2014

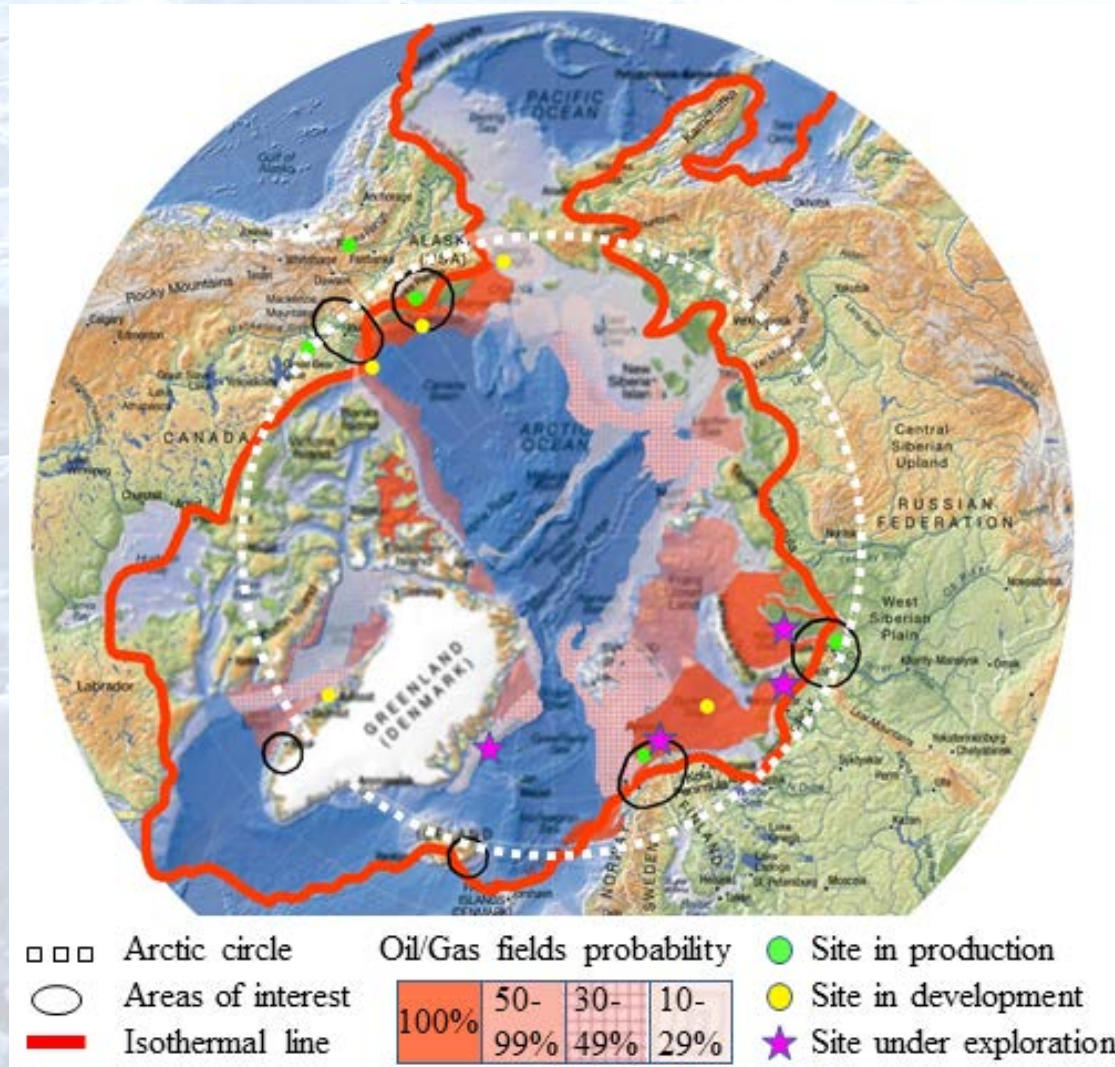
## **The use of the new high strength steels in arctic steel structures**

Markku Pirinen, Lappeenranta University of  
Technology, Finland

# Limited data on climate and its variability



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Lack of data on ice

Environmental concerns

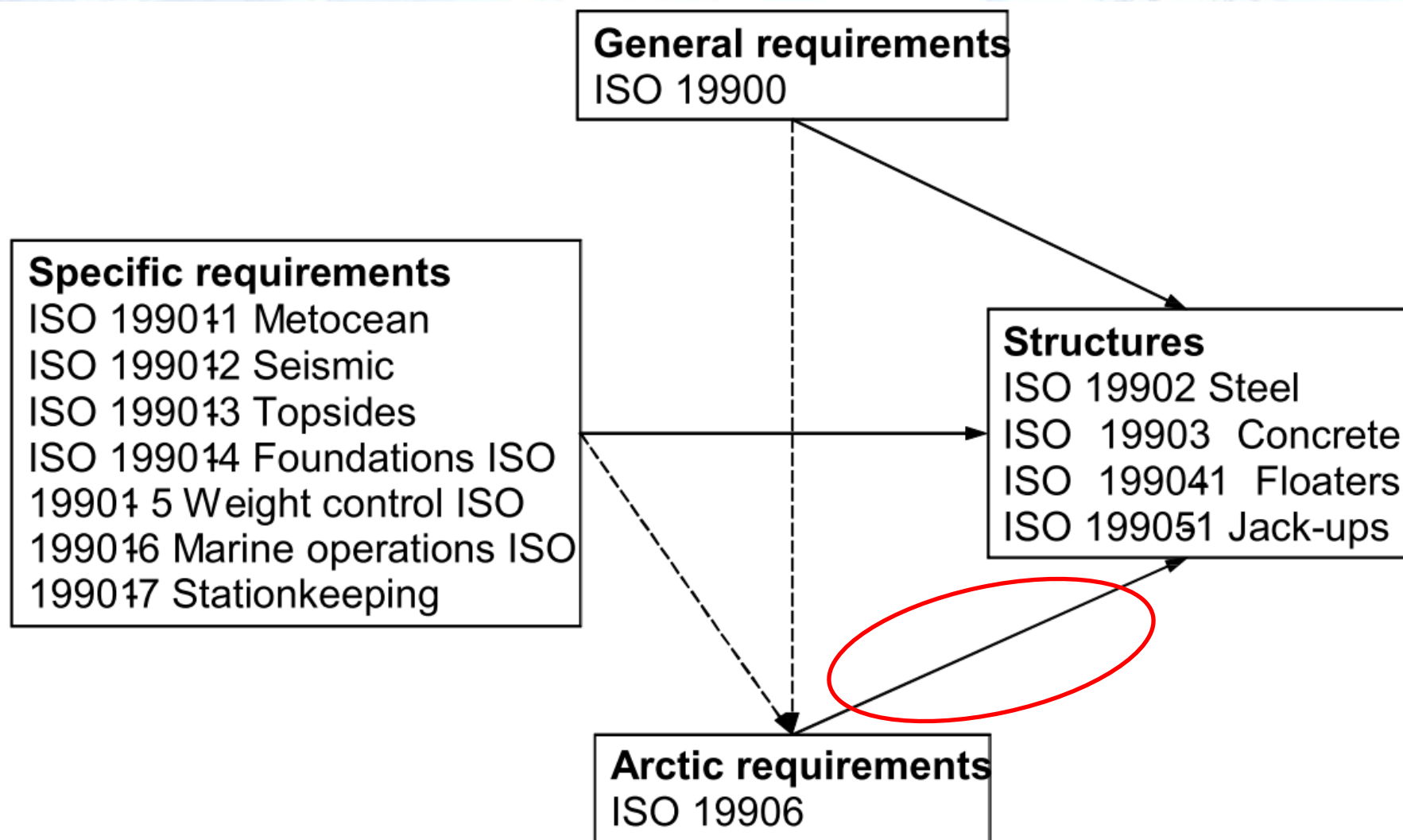
Increase in climate variability

# Limited experience in the Arctic

(1/2)



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# Limited experience in the Arctic <sup>(2/2)</sup> : Material standards



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EN 10225

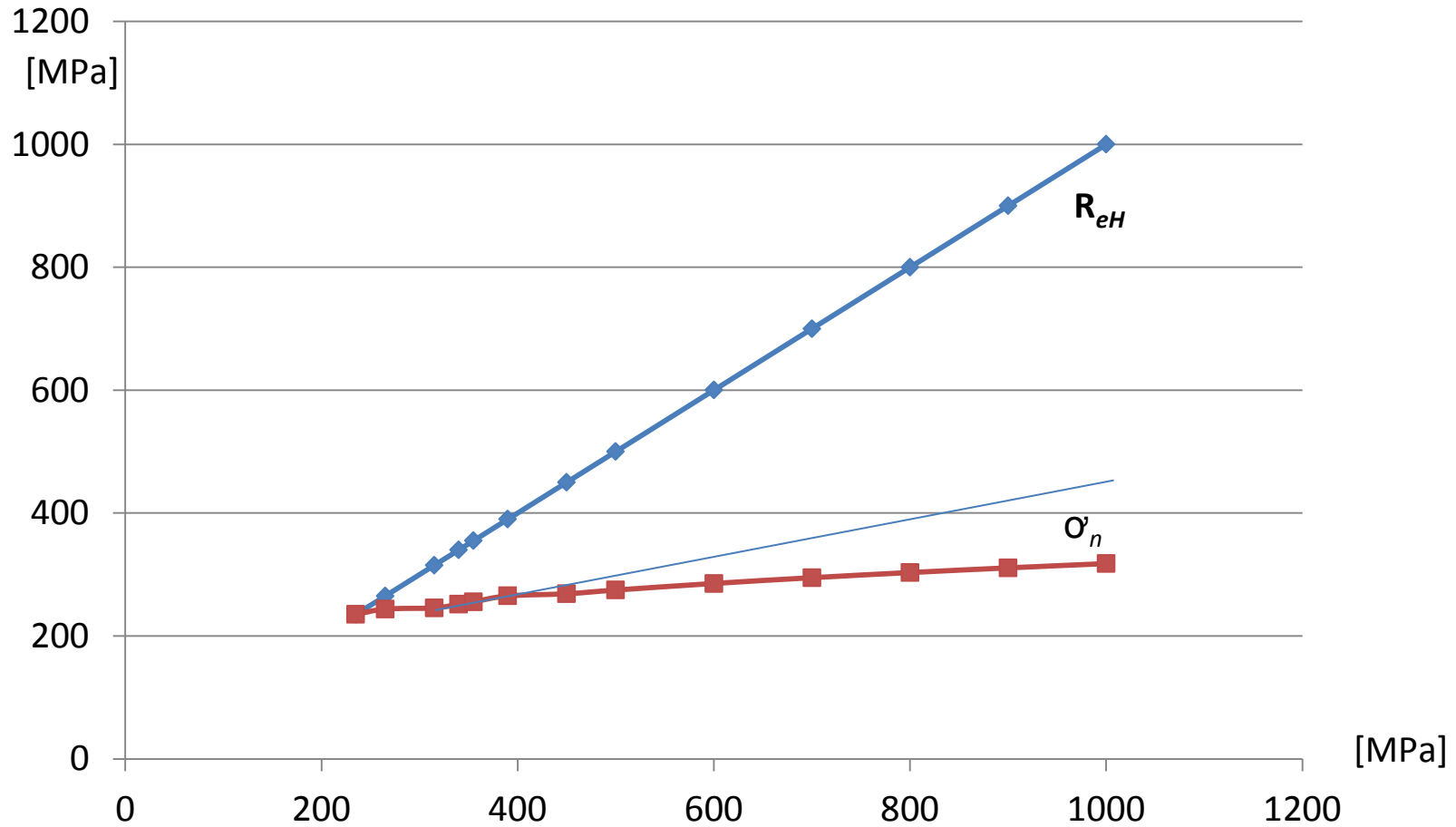
API 2W

NORSOK M  
101

| Base material                                 |                                    | Weld material                      |
|---|------------------------------------|------------------------------------|
| Required tests                                | Optional tests                     |                                    |
| Chemical analysis                             | Through thickness testing          | Tensile test                       |
| Tensile testing                               | CTOD testing (Carried out at LAST) | Charpy testing                     |
| Charpy testing (Carried out at LAST -0 -30°C) | Weldability testing                | Bend testing                       |
|   |                                    | Hardness testing                   |
|   |                                    | CTOD testing (Carried out at LAST) |



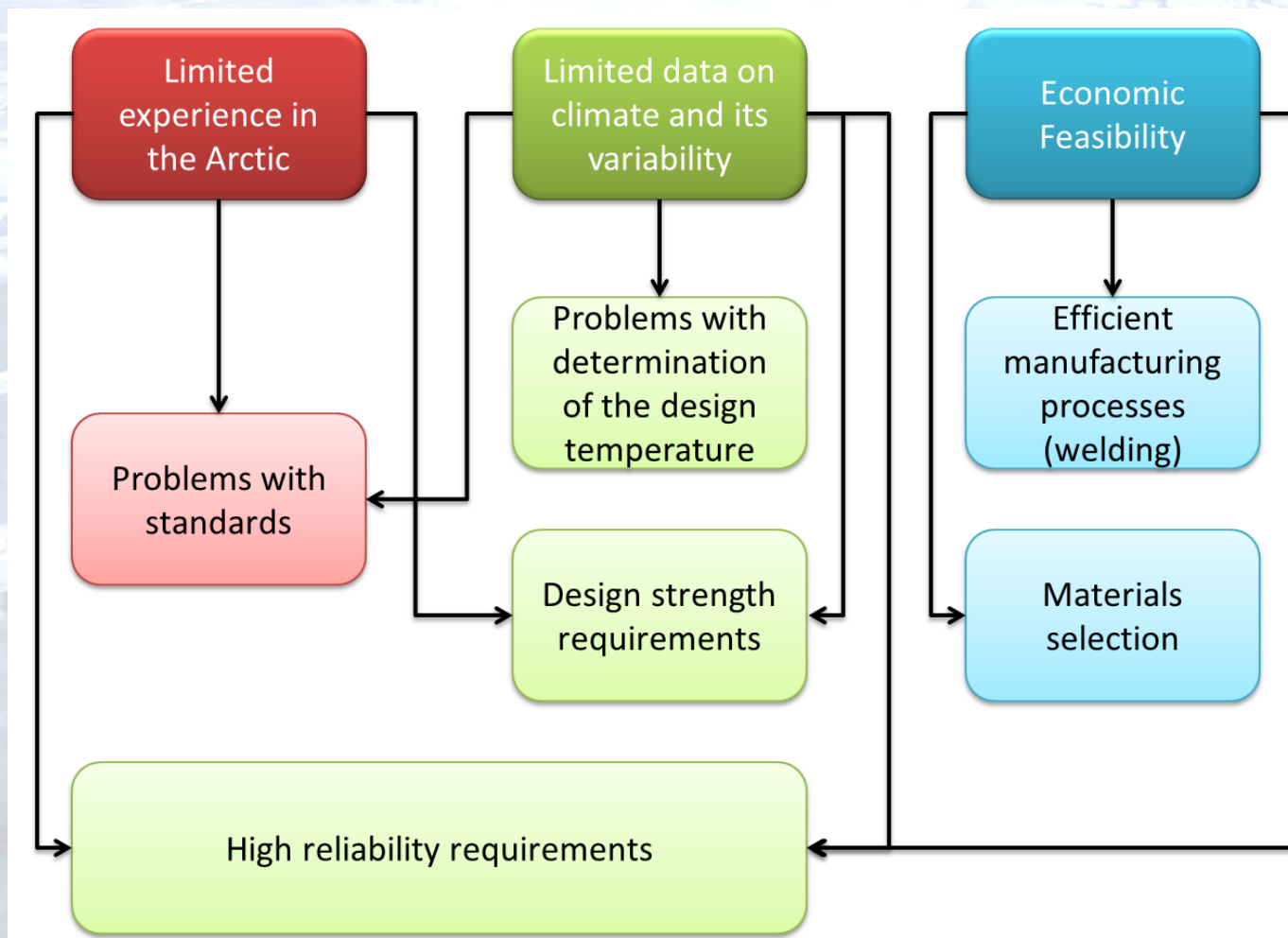
# Design stress vs yield stress



# Factors of uncertainty in the Arctic



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# Gas and oil platforms



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## Upper part

Temperature down to  $-60^{\circ}\text{C}$ , sea air.  
Loads: seismic, wind and waves.

## Upper part of a supporting block

Temperature down to  $-60^{\circ}\text{C}$ , sea water, air. Loads: cyclic, axial, shear, static and seismic.

## Ice-resistant girder at the waterline

Temperature from  $-2^{\circ}\text{C}$  to  $-60^{\circ}\text{C}$ , sea water, air. Corrosive environment. Loads: cyclic, bending, axial, static and seismic.

## The base of a platform

Temperature  $-2^{\circ}\text{C}$ , sea water, biofouling. Corrosive environment. Loads: cyclic, bending, shear, axial, static and seismic.

Environmental demands in Arctic are different than in warm environment. Ice, glacier, coldness, darkness, etc. are hazardous elements in Arctic.



# Arctic Materials Technologies Development-project



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- Two partners, Lappeenranta University of Technology and Central Research Institute of Structural Materials, PROMETHEY
- Main issue is materials used for Arctic and welding. Materials are high strength steels, nanomaterials, coating materials, etc. In welding we used new processes.
- Funding is from ENPI program
- Budget is 1.027 M€ and project time is 1.1.2012-31.12.2014
- Results:
  - Comparison of Russian and European materials
  - Reliable methods for testing materials and structures for Arctic
  - Recommendations for norms and standards based on research
  - Welding of new high strength steels for Arctic based on research
  - Scientific articles and thesis, inter alia doctoral thesis



FSUE CRISM "PROMETHEY"



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ENPI



# Icebreakers manufacturing in Helsinki



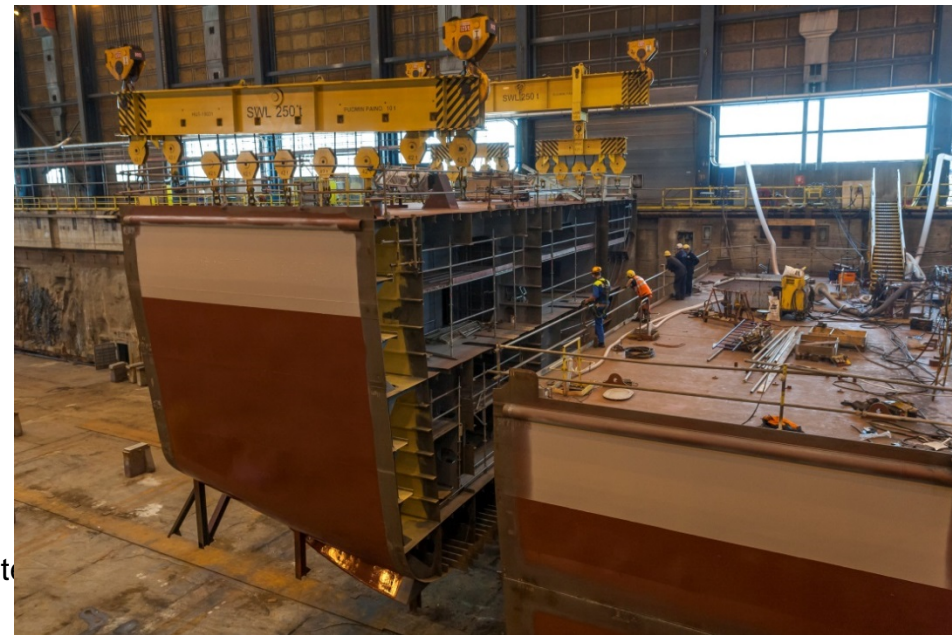
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NB 508 Baltika is the world's first oblique icebreaker

A) Blocks are coming to shipyard

B) Installation of blocks inside shipyard



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# Successful solutions



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