

# Synthetic HMPE fiber Rope Application in Hot Climates

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# Background

Many areas of new oil and gas reserve development and production are occurring in the Middle East, the Northwest Shelf, Western Africa, or other regions that have extremely high climatic temperatures and utilize ocean going vessels to transport this cargo to their ultimate destination. With the OCIMF's\* recent acceptance of synthetic mooring lines, **H**igh **M**odulus **P**oly**E**thylene (HMPE) fiber based mooring lines are now being considered for use, but the fiber's relatively low melting point and published critical temperature have raised concerns about the product viability in these climates.

\*OCIMF: GUIDELINES ON THE USE OF HIGH-MODULUS SYNTHETIC FIBRE ROPES AS MOORING LINES ON LARGE TANKERS, First Edition 2002







# AmSteel Blue

- Made from HMPE Fiber
- Size-for-Size Wire Rope Replacement
- 1/7<sup>th</sup> the weight of wire rope
- Excellent Resistance to:
  - UV
  - Abrasion
  - Most Chemicals

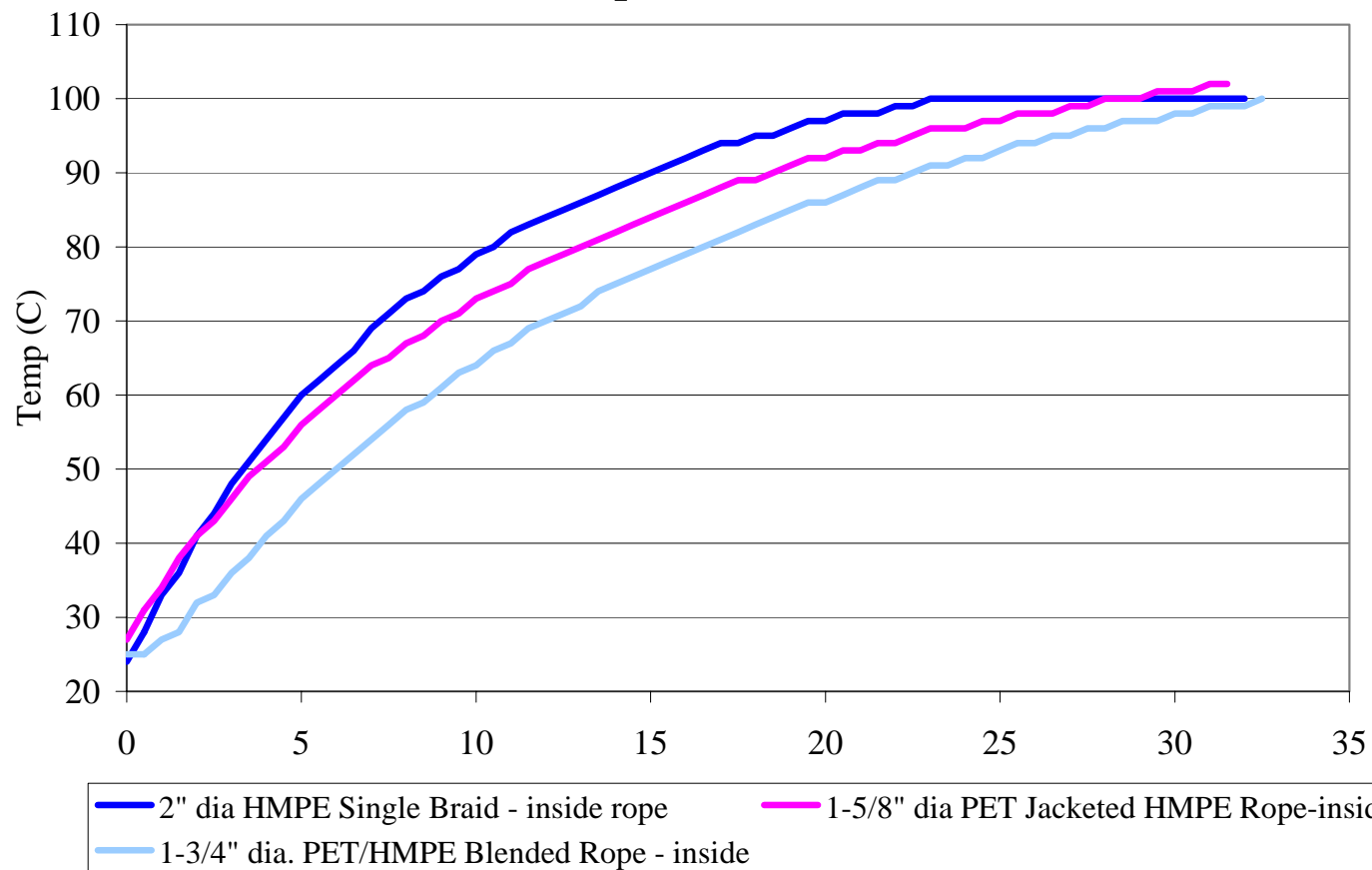
# Goal

- Effects of Ambient Temperature on:
  - Time required for the rope temperature to come to equilibrium with ambient temperature
  - Residual Strength after long term exposure to elevated temperatures
  - Strength at elevated temperatures
- Effects of Conducted Heat
- Effective Rope Lifetime as a function of Creep

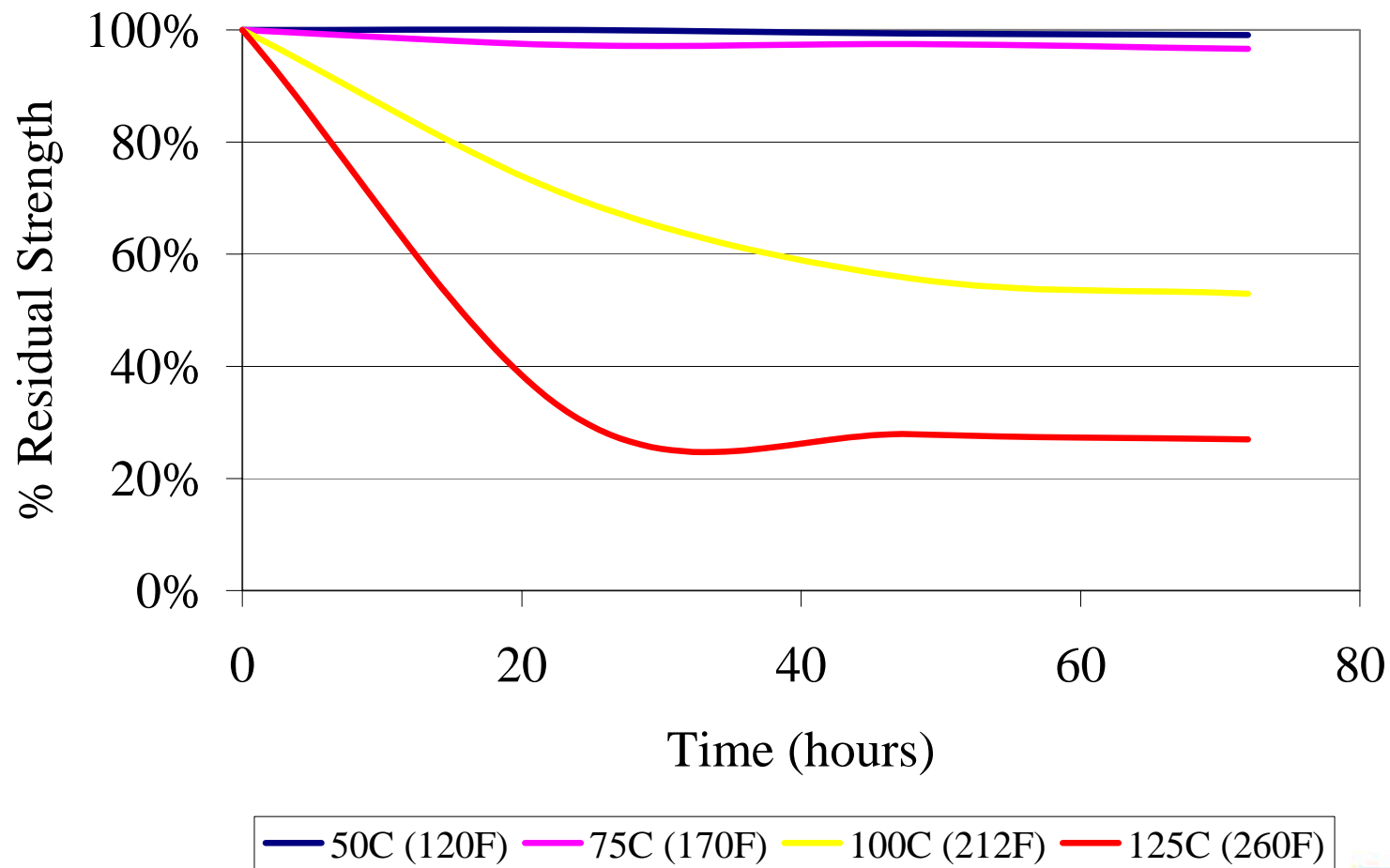


# Effects of Ambient Temperature: Time to Equilibrium

Heat Transfer:  
Time to Equilibrium (< 30 minutes)

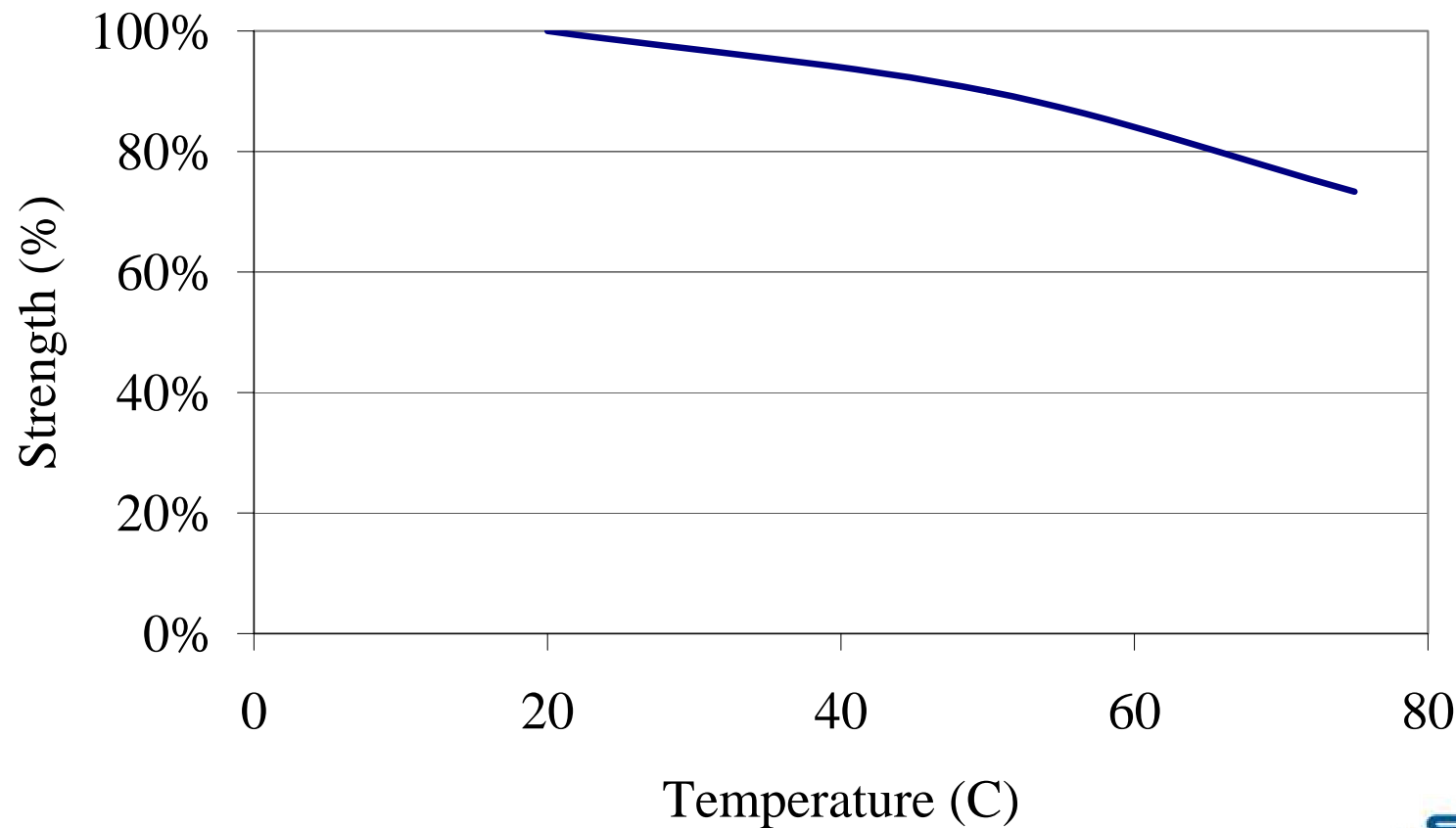


# Effects of Ambient Temperature: Long Term Exposure to Elevated Temperatures



# Effects of Ambient Temperature: Strength of HMPE Fiber at Elevated Temperatures

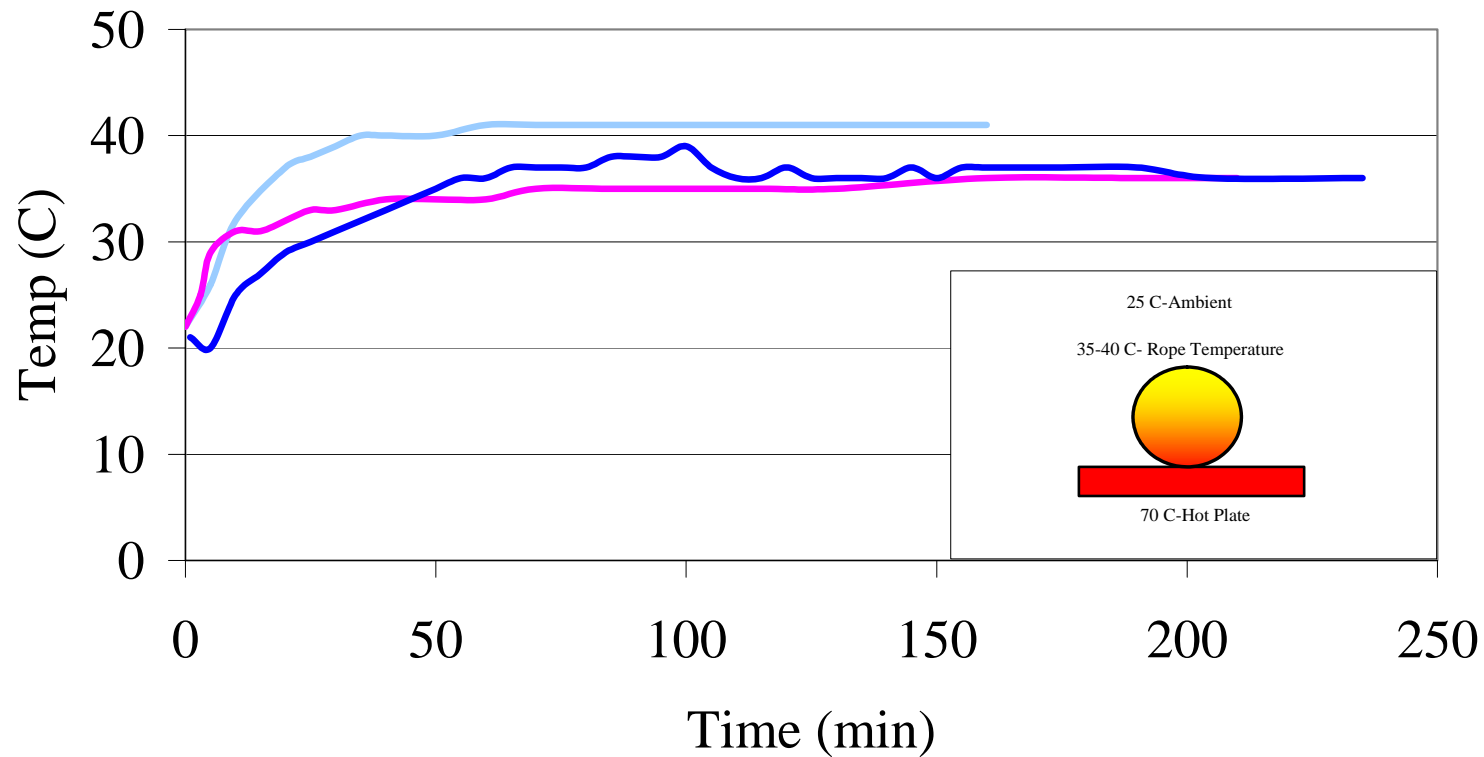
Strength at Temperature





# Effects of Conducted Heat

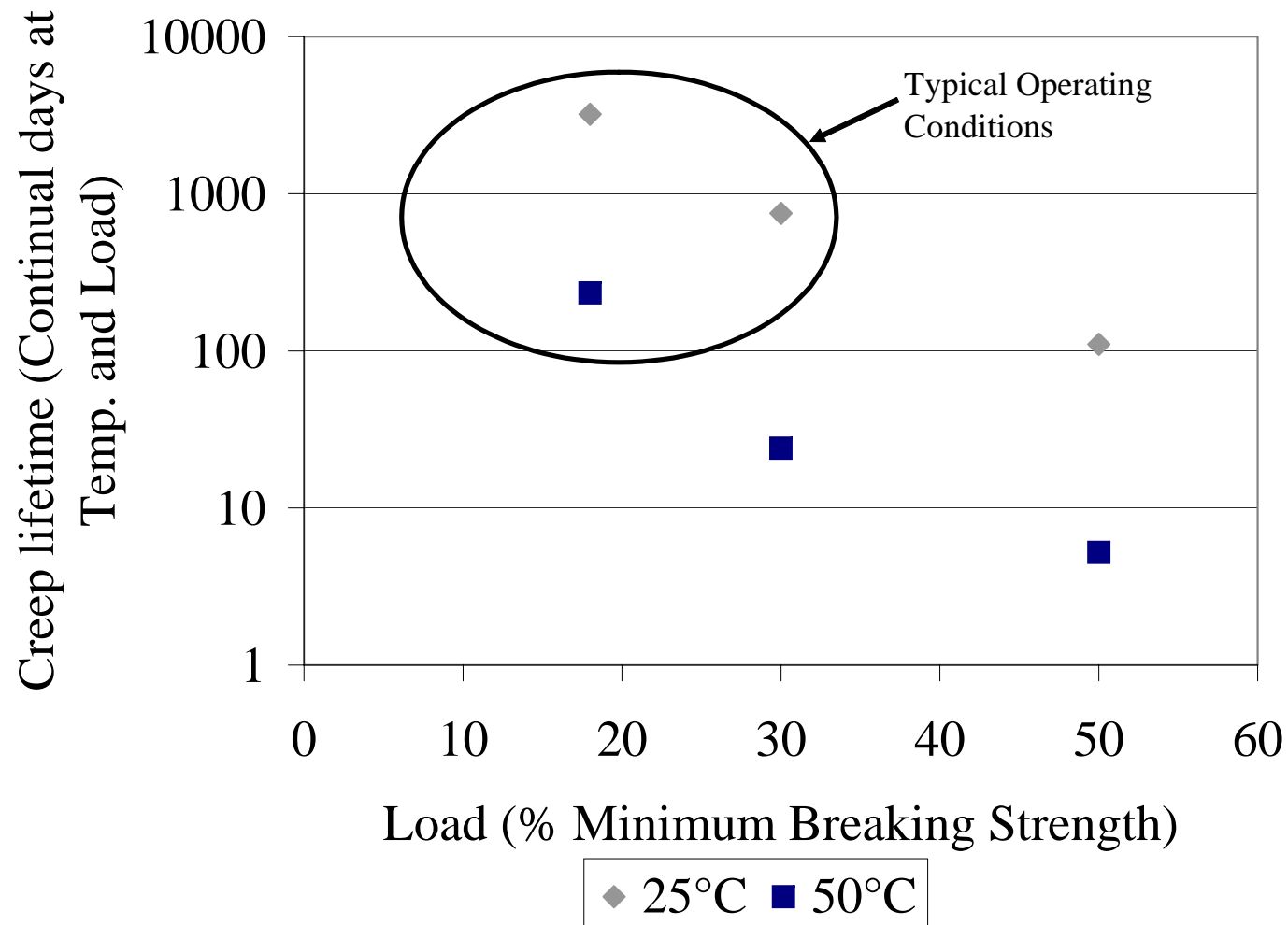
1-5/8" Rope on 70C hotplate



— 1-5/8" PET/HMPE Blended Rope — 1-5/8" PET Jacketed HMPE Rope  
— 1-5/8" HMPE Single Braid

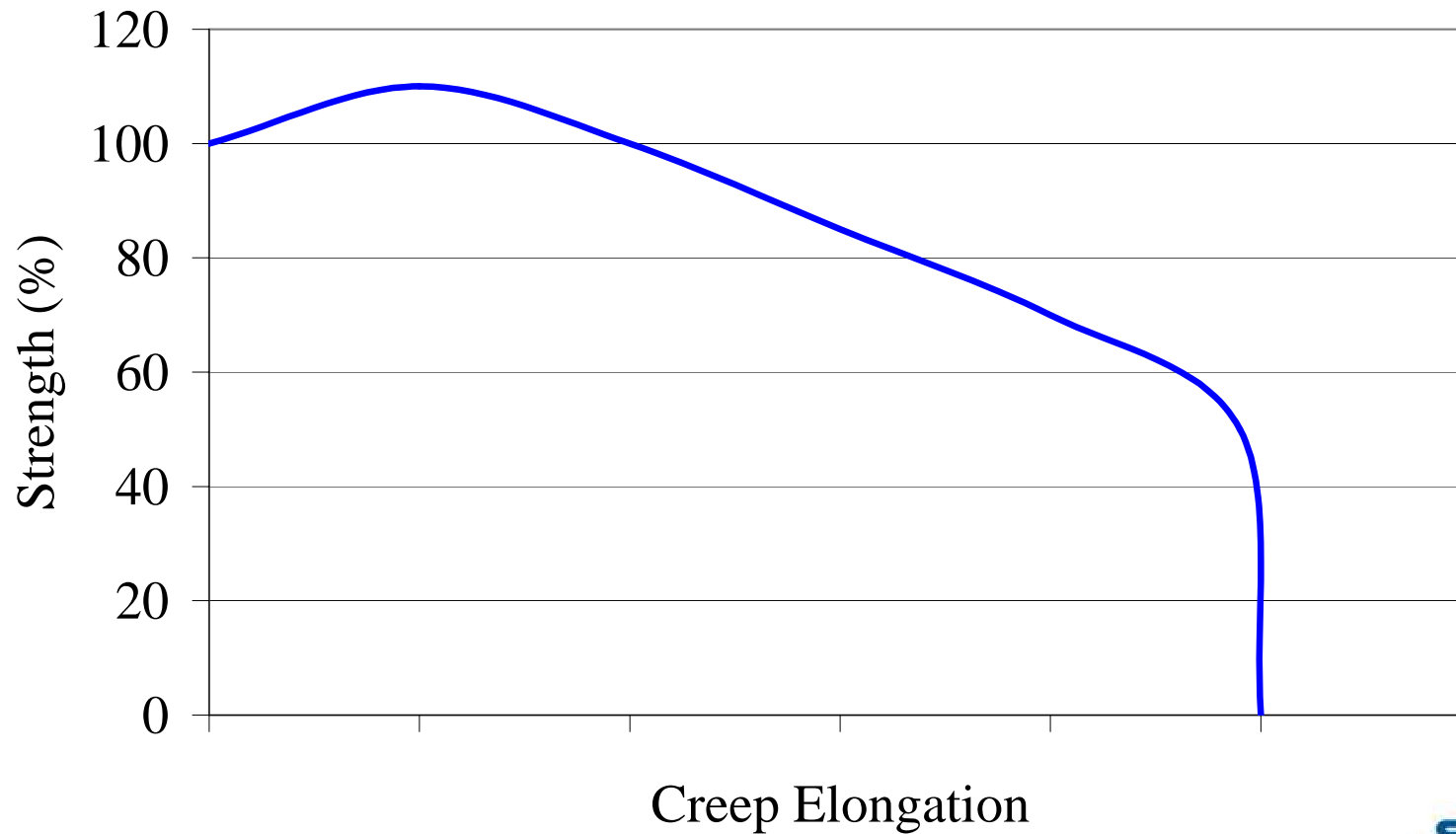


# Creep Lifetime



# Analysis of Heat, Time, and Load: Strength versus Creep Elongation

General Creep Behavior of HMPE Fiber Rope



# Creep Lifetime Definition

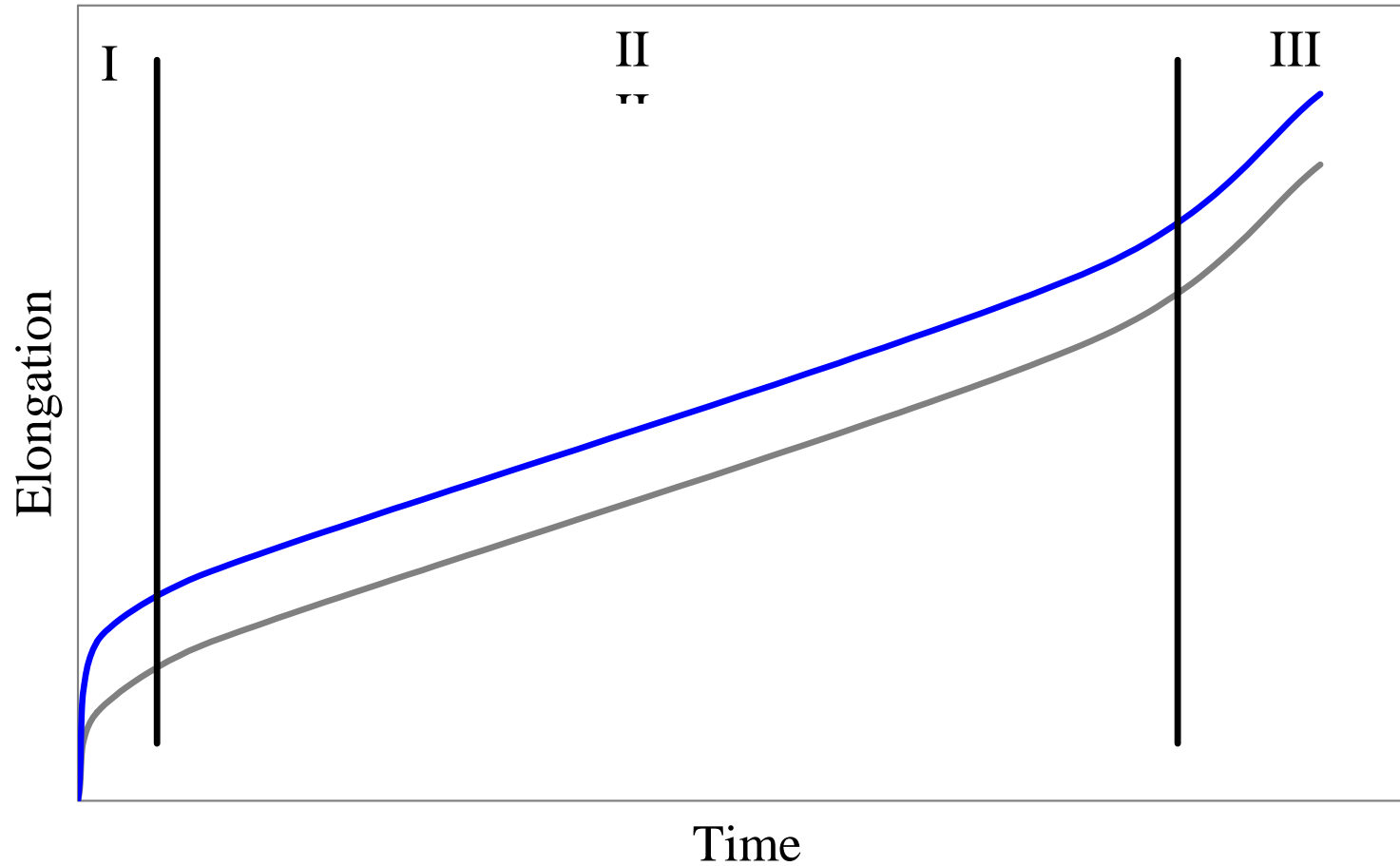
Laboratory study has shown that creep elongation can be categorized into three phases.

- Phase I is characterized by initial elastic elongation.
- Phase II by the onset of permanent fiber elongation
- Phase III by rapid elongation and fiber rupture.

Creep Lifetime is the amount of time required to reach Phase III.



# Creep Model



— HMPE Fiber — HMPE Rope



# Analysis of Heat, Time, and Load: Effective Lifetime Determination

*Example: LNG Tanker trading in Qatar and Europe*

	Mooring Conditions		
Scenario	Worst Case	Practical	
Load Level	30% MBS	30% MBS	10% MBS
Time Moored (Hours/year)	574	12	562
Temperature	50°C	6 hours @ 50°C 6 hours @ 30°C	281 hours @ 50°C 281 hours @ 30°C
Creep Lifetime	> 10 years	> 40 years	



# Conclusions

- Ambient Temperature heats everything in the environment. Jacketed Ropes do not offer any protection from ambient heat
- Exposing a HMPE rope to temperatures between 20 and 75 C results in negligible room temperature strength loss. However, the breaking strength of HMPE fiber decrease by 8% at 50 C.
- Heat can be conducted from a hot surface to HMPE Rope but the temperature will not reach the temperature of the hot surface.
- HMPE Ropes can survive for more than 40 years under in hot climates under load as the simulation study shows.

