# Notes on test method to establish hydrogen compatibility of materials for fuel cell vehicles

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# How do we standardize materials selection methods for high-pressure $H_2$ service?

- **Design-based method:** *ASME pressure vessels*
  - **Measure reliable *design data***
  - **Prescribed component design methodology**
  - **Data often included in the code or standard**
- **Performance-based method:** *vehicle systems*
  - **Establish materials *performance metrics***
  - **Design information/method is not specified**
  - **Often used in the context of system performance and specific application requirements**

***Goal*: Establish performance-based test metrics consistent with the requirements of fuel-cell vehicles**

# Fatigue was determined by SAE committees to be critical and relevant performance metric

- **SAE J2579 requires evaluation of fatigue (eg, pressure cycling)**
  - **Therefore, the test metrics for H-effects must include fatigue assessments**
  - **NASA screening data, for example, does not include fatigue assessment and should not be the basis of materials selection for fatigue resistance**
  - **NASA tables only consider tensile data, while design of high-pressure systems will consider potential failure modes (such as fatigue and fracture)**

**SAE has determined that a fatigue performance is necessary to evaluate materials for high-pressure service on vehicles**

# Results of so-called 'SAE round robin' testing were published

- C. San Marchi, J. Yamabe, M. Schwarz, H. Matsunaga, S. Zickler, S. Matsuoka, H. Kobayashi: "Global harmonization of fatigue life testing in gaseous hydrogen", (PVP2018-84898), Proceedings of the 2018 ASME Pressure Vessels & Piping Conference, 15-20 July 2018, Prague, Czech Republic
- Testing requirements are NOT extensive
  - Option 1
    - 3 notched fatigue tests: about 28 hours each
    - Can be completed in a little over one (1) week
  - Option 2
    - Not required if option 1 is completed
    - Smooth fatigue testing requires about 3x effort

**Testing requirements are not onerous**

- Compare testing requirements in ASME, for example, which are much more difficult and require many months of testing

# Additional (personal) perspectives

- Safety should not be compromised because something is 'difficult'
- If commercial testing services are not adequate, industry must invest in developing those services
  - It is not appropriate to forgo due diligence on safety critical hardware for lack of investment
- Other options exist:
  - Full-scale hydrogen pressure cycling
  - Development of design-based methods or adoption of the ASME Code

**SAE method is an efficient test methodology, which is significantly less intensive than other industries**