Three welding methods are being studied for vanadium alloy welding.

- Electron beam welding
  - produces good welds
  - Vacuum chamber required
    - limits size of component
- Laser welding
  - field useable within limits
  - can use cover gas
- Arc welding
  - field useable
  - can produce large full penetration welds

Laser welding can achieve a DBTT of 0°C using a flexible environmental chamber. Significantly better quality can be obtained with NIFS-1 material.

Arc welding can achieve a DBTT of -20°C using a high-purity glove box.

Several factors have been found important in vanadium welding.

- Purity of atmosphere
- Purity of filler metal
- Purity of base metal
- Grain size

Status and future directions

- Satisfactory welds can be made with all three methods
  - but, all require good environmental chambers
- High purity filler metal might provide a margin to reduce the purity of the atmosphere
- High purity base metal, NIFS-1, has reduced Al, Fe, and Nb
  - effects should be investigated
- Doping should be investigated further to reduce grain size, N, Y

Conclusions and Recommendations

- Continue welding research on V-alloys
- Improve interstitial purity of V-alloys, at least for filler metal
- Investigate grain size effects
- Develop a combination of purity and grain size to permit a lower purity atmosphere
- Investigate irradiating welds
- Weld irradiated material
- Use fracture toughness rather than Charpy testing
- Continue study of laser and arc welding methods
- Look into friction stir welding