INL/MIS-20-58098-Revision-0

Microwave Fire Lessons Learned

Robert V Fox

December 2019

The INL is a U.S. Department of Energy National Laboratory
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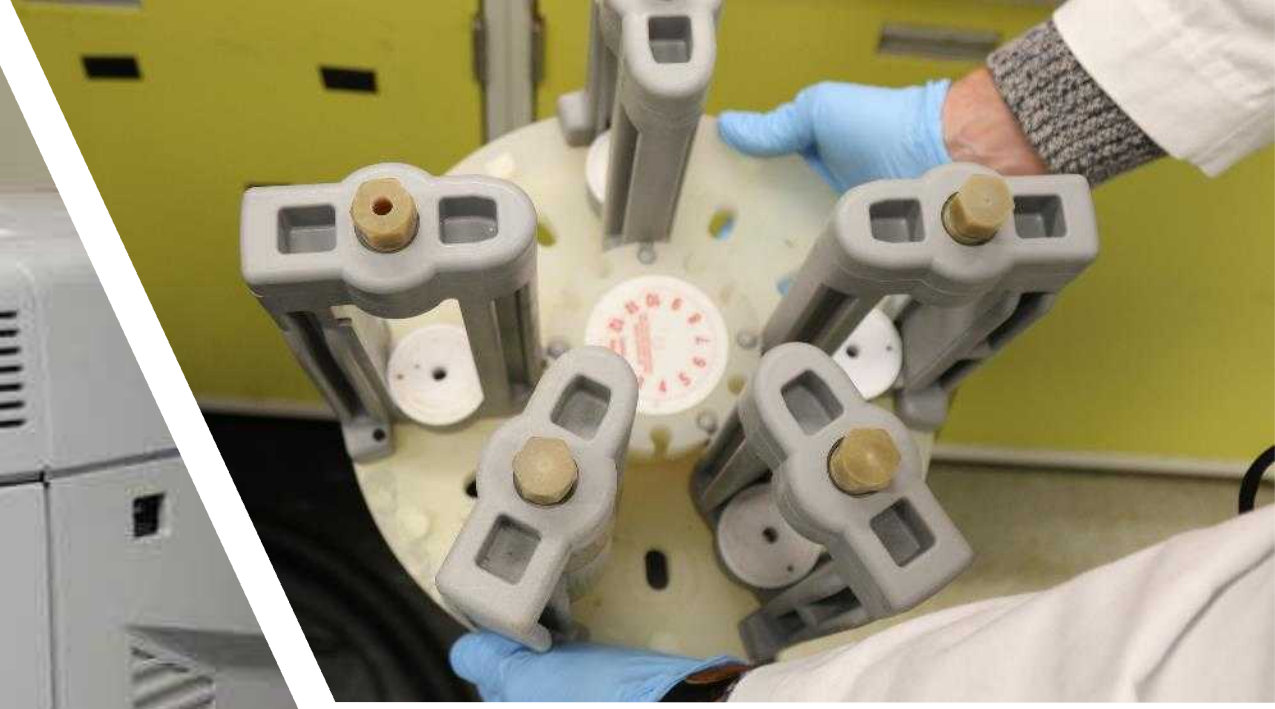
CEM Mars 6 Incident
November 6, 2019


ONE TOUCH
MARS




CRAFTSMAN
MARS
CEM
LAB A4 Biotechnol


ON TOUCH
Biotechnology LAB


STANLEY®
1
2
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6


FIBER OPTIC COMPONENT, HANDLE WITH CARE
CEM
Fiber Optic Temperature Sensor
Model: Probe, RTP-300 Plus
Part #: 314305
Serial #: TI4962D
Gauge Factor: 4403506
Range: -40 TO 250°C
FIBER OPTIC COMPONENT, HANDLE WITH CARE
Made in Canada
RNING
UE RTP-300+ probe in a
on System. Improper
ol will result, and could
use a safety hazard.

Fiber Optic Probe Guide

MARS 5 & MARS 6™

MTS-300

P/N 314355

White probe with white end

Temperatures < 250 °C

MARS 6 only

MTS-300 High Temp

P/N 281461

White probe with black end

Temperatures > 250 °C

MARS 6 only

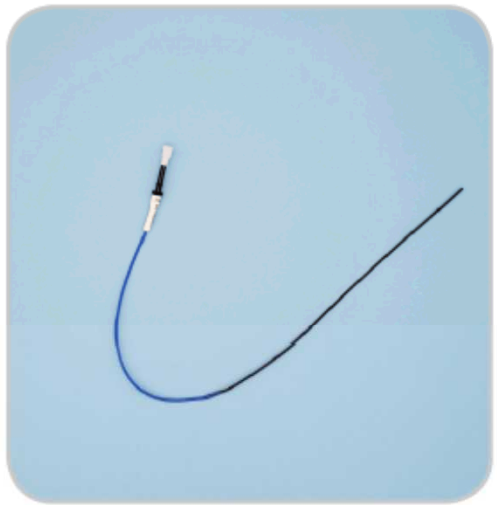
RTP-300+

P/N 314305

Blue probe with blue end

Temperatures < 250 °C

MARS 5 only



RTP-300+ High Temp

P/N 314306

Blue probe with black end

Temperatures > 250 °C

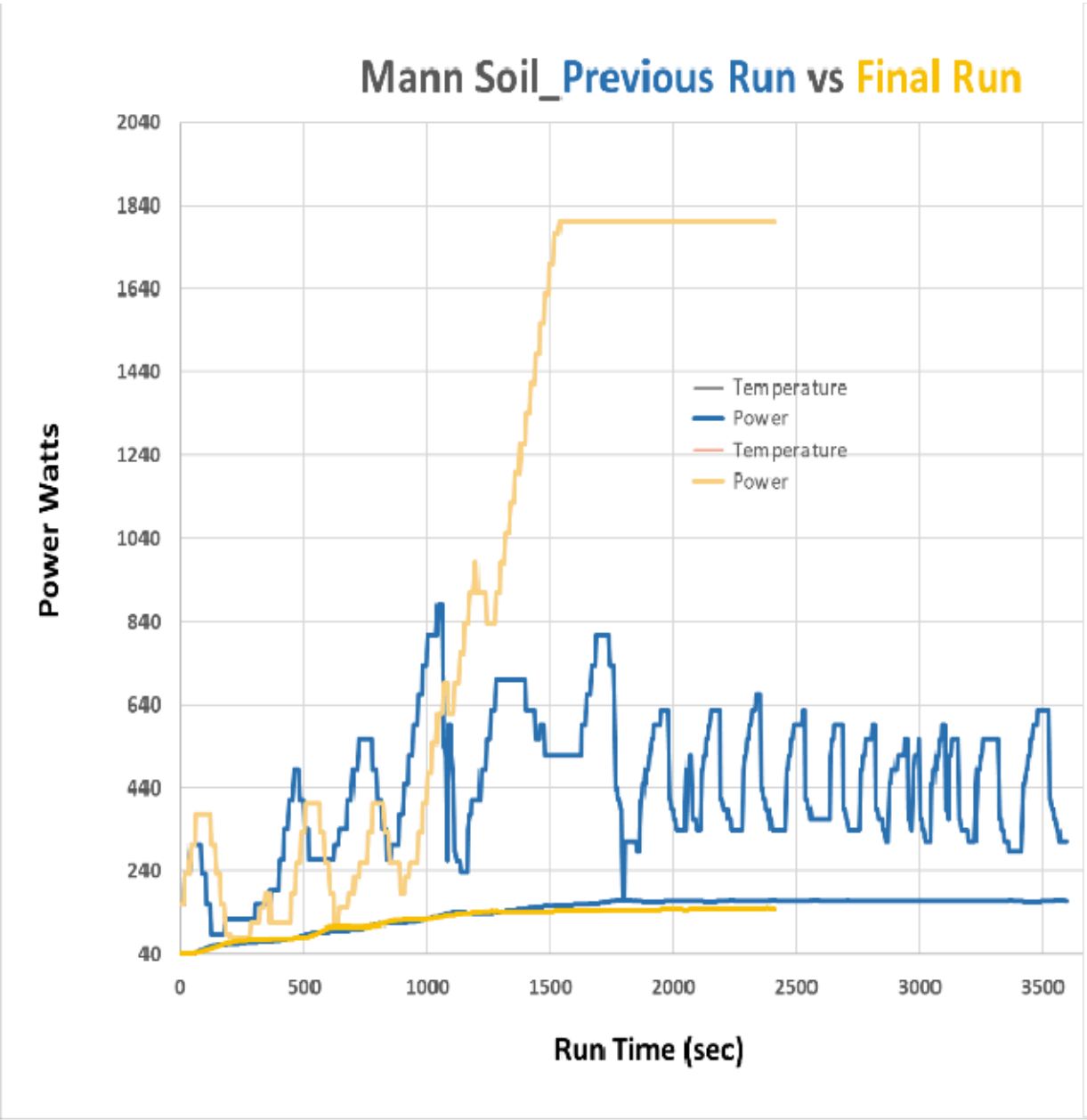
MARS 5 only

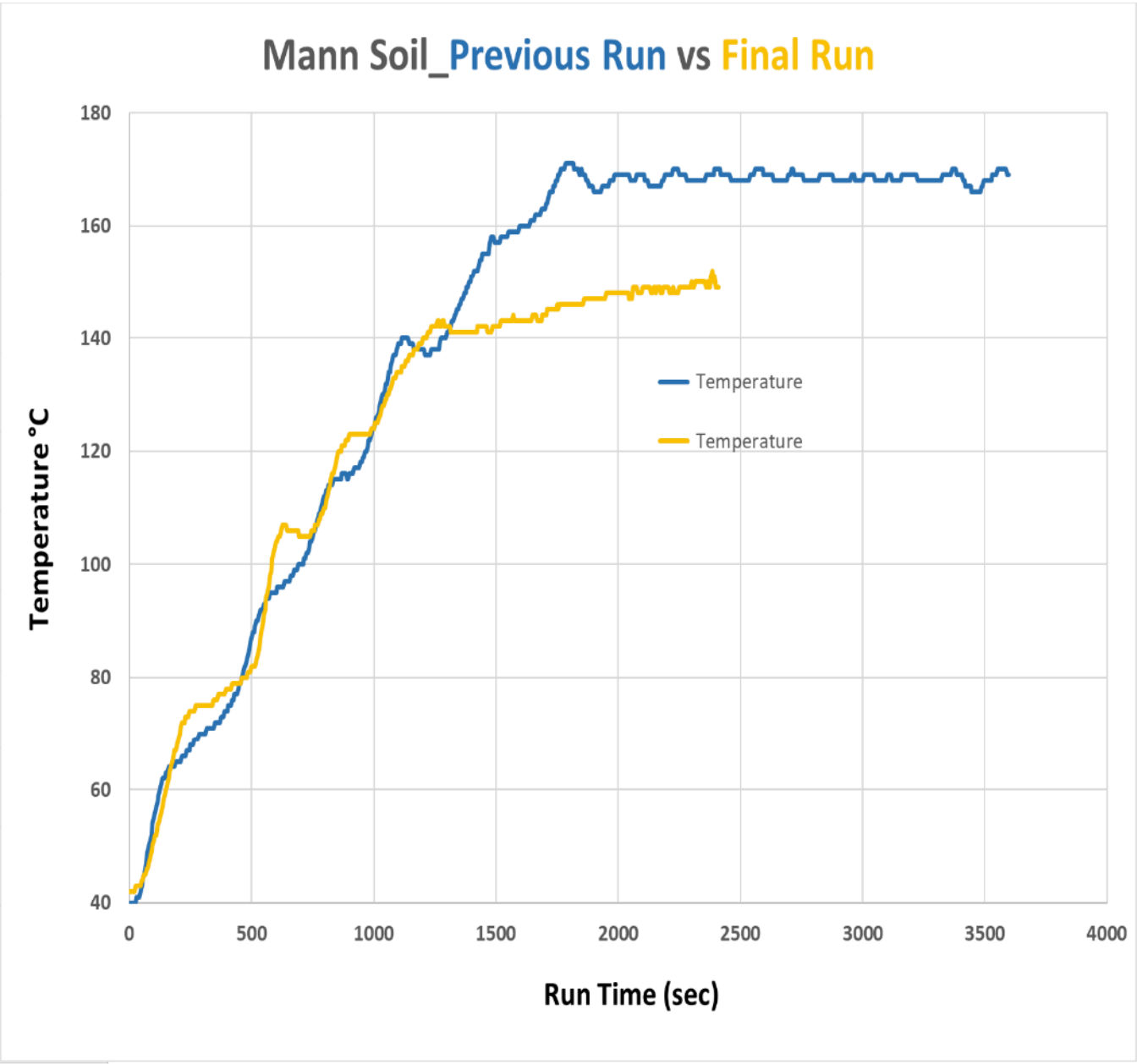
**RTP-300+ probes are not compatible with the MARS 6 unit as they are shorter than the MTS-300 probe and will not reach the bottom of the thermowell in the control vessel if used in the MARS 6.*

Run Time Report From microSD Card

- microSD card removed from the microwave and sent to CEM.
- Method running during the last run was “Mann Soil”. A 60-minute run.
  - Power = 1800 W
  - Ramp over 30 minutes to 170 °C.
  - Hold at 170 °C for 30 minutes.
- Software version 1.26. Latest MARS 6 software is version 1.51
- Thermocouple GF = 448-9482, Probe S/N TJ5009N, MTS-300 MARS 6 probe.
- Power/Temp./Time data from the final run was compared to previous Mann Soil runs that were successfully completed.
- Power/Temp. ramp consistently for ~22 minutes. At that 22 min. the temperature rise slows significantly and levels at ~141 °C. In response to the temperature lag the microwave went to full power 1800 W for ~14.5 minutes, but the temperature only went to ~149 °C. The run was aborted at 40.1 minutes by the ReactiGuard.
- CEM concludes that continued and prolonged application of 1800 W caused for over-heating and subsequent fire.

Runtime Data



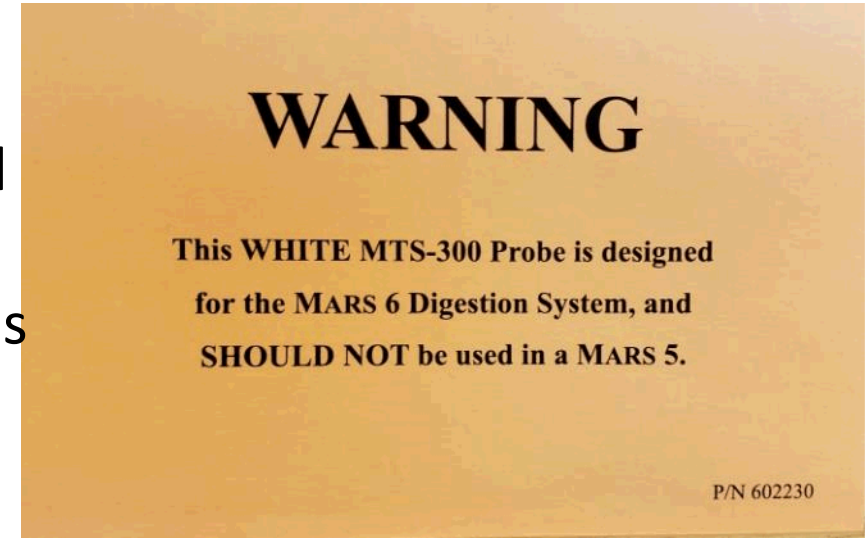


Contributing Factors

- Blue Mars 5 thermocouple probe (16”) used in a Mars 6 device. Incorrect S/N and GF.
- Unattended run. Acid fume sensor (optional, but not purchased) on exhaust line not used.

Additional Information: HPI

- Mars 5 thermocouple kept with Mars 6 spare probes and Mars 6 device.
- Mars 5 thermocouple fits into the Mars 6 connector and will not ERROR OUT.
- Thermocouple product boxes and labeling are similar. Probes not returned to their original boxes.
- At least 3 different colored warning labels containing 4 different warnings in probe boxes.
- A 100-page user manual that mentions nothing about Mars 5/Mars 6 part incompatibility.
- No known product recalls or other warnings for incompatible probes.



Lessons…….Learned?

- CEM database showed the microwave was owned by a company located in North Carolina. INL Procurement using 3rd party vendors, who gets the updates?
- Cognizants listed in the CEM database for this instrument were INL staff present at the time of installation.
- User Manual revisions. Critical software revisions. Research staff not notified of updates.
- Storage of incompatible parts with compatible parts.
- Safety equipment listed as “optional” by the manufacturer. Equipment not purchased.
- New probe (safety-critical equipment) installed in a device w/o consulting manufacturer’s operating instructions or investigating specifics regarding the thermocouple.
- Incorrect serial# and Gauge Factor programmed into the instrument.
- No evidence of routine maintenance of the torque wrench.
- Over-reliance on equipment, the manufacturer, on past successful runs, and on personal knowledge/skills.
- Sign blindness. Bright orange WARNING label in the probe box.
- Conditioning/culture that enables us to ignore instructions and warning labels.