Presentation Title:

Partnering for A Solution: A Case Study

Abstract:

A material-related issue has been identified, which has the potential of impacting the Space Program. Although "in-house" efforts have been underway to solve the problem, a solution has not yet been reached. This presentation shows how a GIDEP member organization is using a Problem Advisory as a solution approach in an effort to receive information from other industry and/or government organizations that may contribute in finding a solution.

Presentation Slides & Notes:

See following attachment. The notes contain what the presenter will actually "say" during the presentation.

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www.gidep.org

Partnering for a Solution

A Case Study

Deyrah Jimenez-Smith
Randy E. Raley

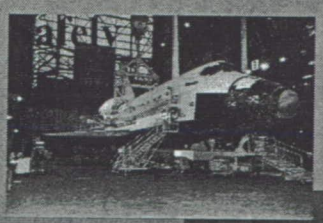
Networking for Solutions

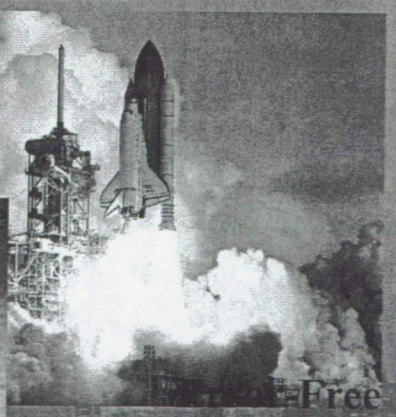
USA United Space Alliance

www.gidep.org

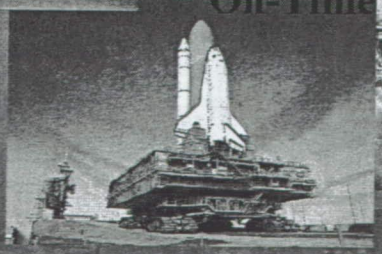
Our Mission

Launch the Space Shuttle





On-Time



Free

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Material Issue Identified

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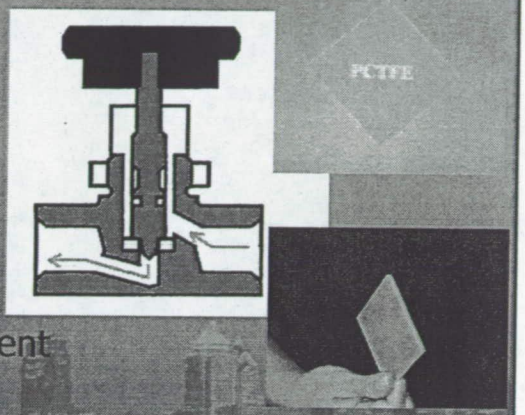
- PCTFE
- Manufacturers
  - 3M → **Kel-F-81**
  - Daikin → **Neoflon**
- "Drop-In" Replacement



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Normal System Operation

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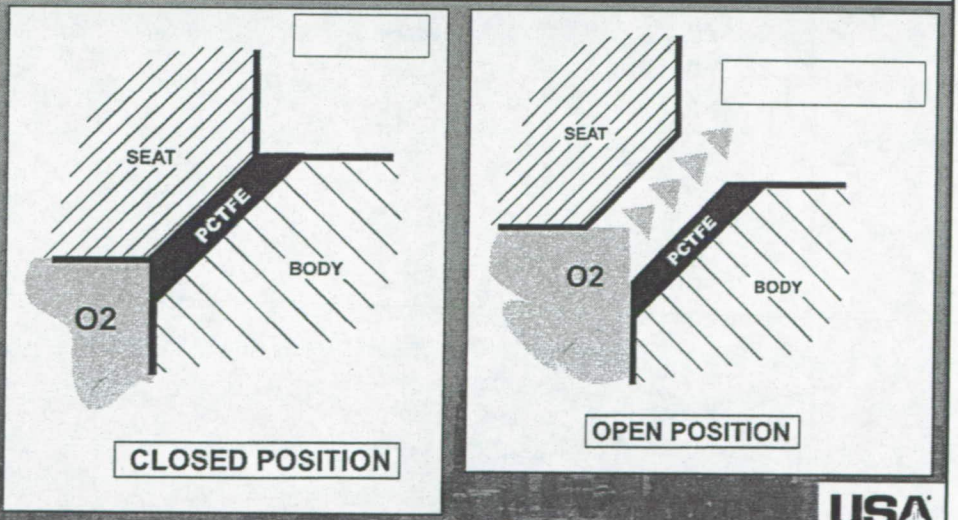

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Differing Material Properties

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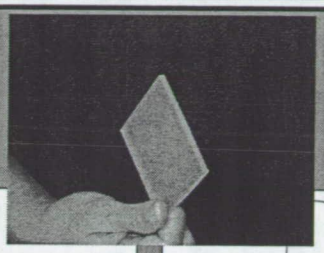
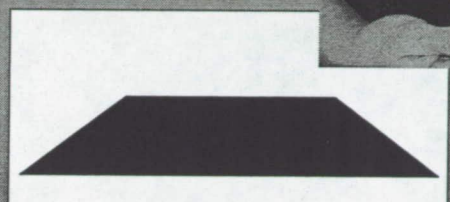
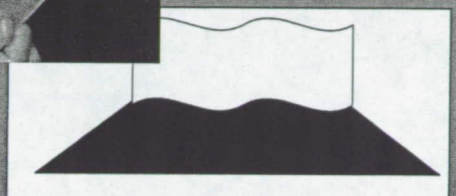




Flat Surface



Deformed Surface

– WSTF Reports - Neoflon

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Possible Events

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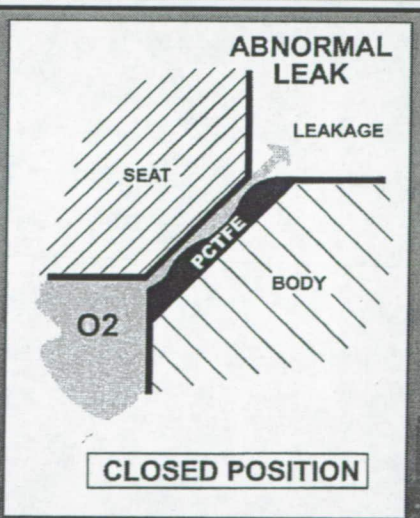
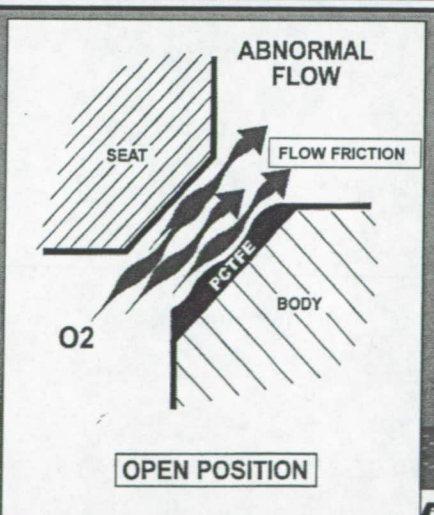


CLOSED POSITION



OPEN POSITION

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Impact

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High Pressure Oxygen Systems

Documented Medical Field Fire Incidents

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PCTFE Working Group

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- Purpose
- No Simple Solution Path
- A Solution Approach
  - The GIDEP Problem Advisory
- Why Not an Urgent Data Request?

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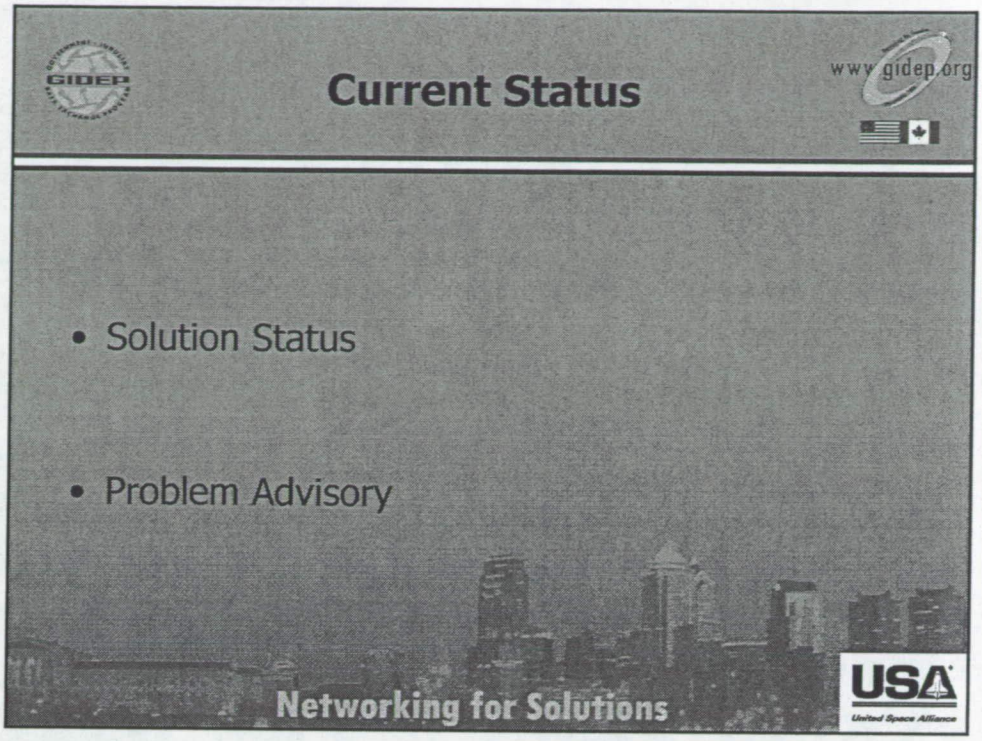
Current Status
www.gidep.org
• Solution Status
• Problem Advisory
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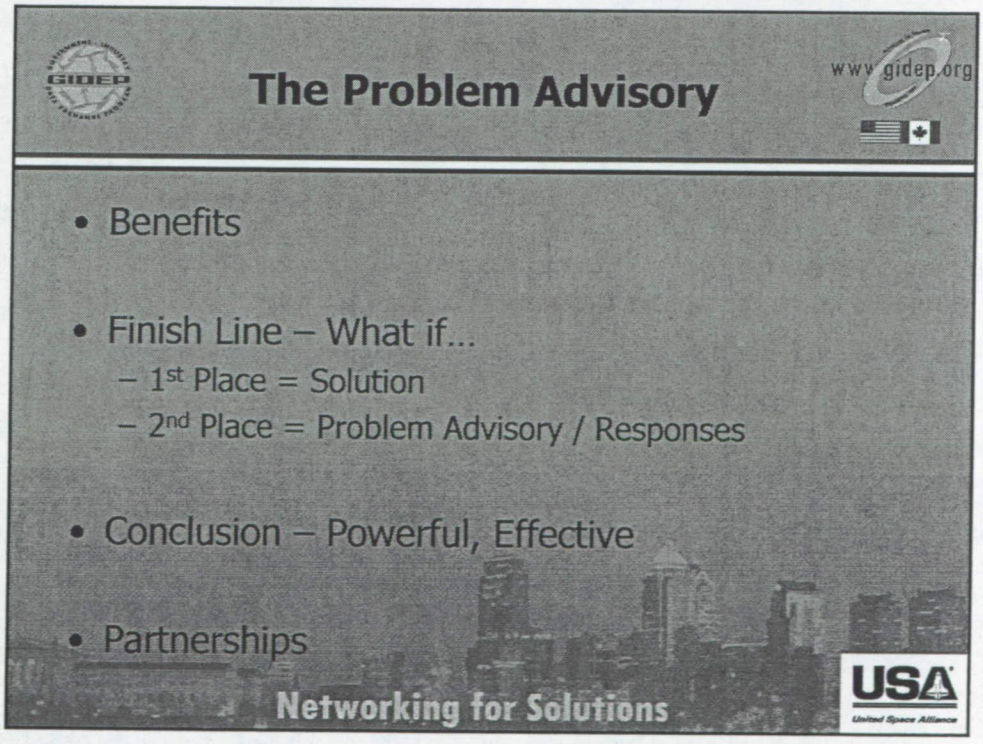
The Problem Advisory
www.gidep.org
• Benefits
• Finish Line – What if...
– 1st Place = Solution
– 2nd Place = Problem Advisory / Responses
• Conclusion – Powerful, Effective
• Partnerships
Networking for Solutions
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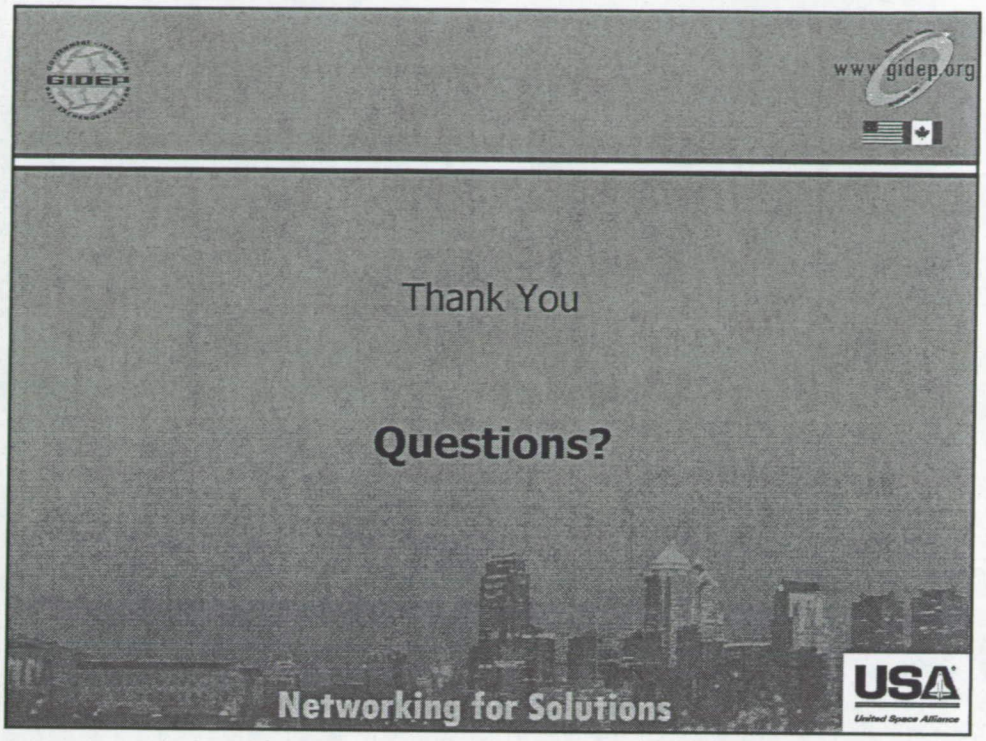
GIDEP
www.gidep.org
Thank You
Questions?
Networking for Solutions
USA
United Space Alliance

Presentation Notes – This is mostly what Deyrah will actually "say".

Partnering for a Solution

- Presentation Title

- Introduction of Presenters
- Work for USA, Cape Canaveral, FL
- Part of Reliability& Corrective AE team, support the Integrated Logistics Element
- Purpose of Presentation – to show how a GIDEP member organization is using a GIDEP Problem Advisory as a solution approach for a material-related problem.
- I'll be going over the slides, but due to the technical content of the presentation, Randy will help answer any technically oriented questions, as his background is in Chemical engineering.

Presentation Notes – This is mostly what Deyrah will actually "say".

Our Mission

- This shows a few pictures of the Space shuttle undergoing processing.
- These pictures are here to depict our company's mission… to Launch the Space shuttle, SAFELY, ON-TIME, and ERROR-FREE

- To give you a brief description of our company
- United Space Alliance is NASA's primary subcontractor for Space Flight Operations.
- Work with many other organizations to process the space shuttle for flight.
- Work in various areas of space hardware processing such as
    - Vehicle processing
    - Payload planning & integration
    - Logistics
    - Facilities operations & Maintenance.
- During the current stand down in flight-operations we've re-analyzed our shuttle processing activities to further assure hardware integrity in all areas.

Presentation Notes – This is mostly what Deyrah will actually "say".

Material Issue Identified

- This slide shows that a material issue has been identified.
- PCTFE is the name of the material
- Two of the original manufacturers include
  - 3M – Kel-F
  - Daikin - Neoflon
- At one point, these different Brand Names were used as Drop-In replacements.

- The picture on the left shows a closed valve that uses PCTFE as its seal material.
- The pictures on the right show what PCTFE looks like.
- PCTFE is a polymer plastic that is widely used in aerospace pressure systems for seals and seats in valves and regulators.
- If you take a look at the picture on the left of the closed valve, the purple area represents the body of the valve, the blue is the stem of the valve, the black is the knob that opens and closes the valve, the area highlighted in yellow is the PCTFE material that is used as a seal for this particular case.
- The arrows point in the direction in which the flow would travel if the valve were to be open.
- Until 1991, all PCTFE approved for use in NASA programs was manufactured by 3M under the trade name Kel-F 81.
- At that time, Daikin also manufactured Kel-F under 3M, but later decided to discontinue its manufacturing of the brand name Kel-F in favor for their own brand name, which they called Neoflon.
- Although they are the same material, the difference in them lies in the manufacturing process used to make them.
- Again, at one point these 2 brands were used as Drop-In replacements with the same part number.

Presentation Notes – This is mostly what Deyrah will actually "say".

Normal System Operation

- This slide illustrates two simplified diagrams of an oxygen valve under normal operation.
- The picture on the left is that of a closed valve.
- While the picture on the right is that of an open valve.

- In both cases, the body and seat material in the valves, which is represented by the stripes, is made of metal.
- And the PCTFE is shown in black as being placed between the body and seat of the valve as a seal to restrict any flow from passing across the valve, when the valve is closed.
- I'd like to Note 2 Items about the diagrams.
    - #1. The PCTFE material in normal system operation is FLAT.
    - #2. When the valve is open, the contents that flow across the valve come in CONTACT with the PCTFE.

Presentation Notes – This is mostly what Deyrah will actually "say".

Differing Material Properties

- This next slide shows first of all a picture of the PCTFE material.
- And, two diagrams depicting what happens to the surface of the material when a property of the material called Dimensional Stability differs.
- I'll also touch on Reports from White Sands Test Facility in regards to Dimensional Stability.

- If the material has Dimensional Stability, its surface will be FLAT.
- On the other hand, if the material possesses Dimensional Instability, then OVER TIME, the surface may become Deformed, and in essence, a Ridge may form.
- In 2003, NASA White Sands reported evidence that the newer Neoflon may exhibit Dimensional Instability that WAS NOT present in Kel-F.

Possible Events

- This slide shows the two valve diagrams, but under abnormal conditions.
- And, it depicts the possible events that may occur when the PCTFE material has deformed due to its dimensional instability.

- If you'll take a look at the picture on the left, this shows a picture of the closed valve.
- But, because the surface of the seal material has been deformed, a LEAK has developed.
- The picture on the right shows an open valve.
- In this case, the deformed surface of the material allows what is called Flow Friction to occur, which can lead to IGNITION of the seal material.

Impact

- This slide shows a picture of the Space Shuttle at the Launch Pad.
- I've placed a note here to indicate that High Pressure Oxygen Systems are located at the Pads.
- And, that this issue can impact these systems.
- I'll also touch on some of the documented fire incidents related to this issue that have happened in the Medical Field.

- I'd like to point out that for most applications such as low pressure systems, the difference in dimensional stability is insignificant.
- But, this material is frequently used in critical systems such as high-pressure oxygen systems.
- And, the consequences of an undesired event would be severe.
- I'd like to mention that there have been document fire incidents in the medical field.
    - In 1992, Patient at home on oxygen smelled odor, developed severe difficulty; died at hospital.
    - In 1994, Pt smelled foul odor when closing cylinder valve; hospitalized for a few hours.
    - In 1998, Pt on anesthesia machine smelled odor which burned her throat, no report regarding injury.
- According to a presentation given at an ASTM Committee Workshop last year, it was acknowledged that the "Recent fires associated with PCTFE plug valve seats may be related to the impingement of gas flow onto the deformed surface."
- And it also brought out the point that the PCTFE's mechanical instability may be have been a factor.

PCTFE Working Group

- The next slide is about the PCTFE Working Group that has been formed.
- I'll talk about its Purpose.
- How No Simple Solution Path has been found.
- And, how one of their current Solution Approaches involves a GIDEP Problem Advisory.
- I'll also talk about why an Urgent Data Request was not used.

- In a "call-to-answer", a working group was formed.
- Its Purpose is to find a solution to this problem before Return to Flight.
- It is composed of different organizations including NASA-KSC, NASA-White Sands, United States Air Force, Boeing/Rocketdyne, Lockheed Martin, and United Space Alliance.
- To give you insight into the group, they hold Telecons every week, and on average 15-20 persons attend.
- Currently, no simple solution path has been found.
- At this point, all high-pressure oxygen systems have been tagged out and will not be used until a solution is found.
- The group has laid out 5 solution approaches to address this issue.
- And, I'll briefly go over these
    - 1. Verify Neoflon supplied by manufacturers is safe for use.
    - 2. Anneal
    - 3. Specification
    - 4. Interim Solution – Preventative Maintenance
    - 5. Replacement Material
- In support of the 1st solution approach to see if the material we currently have is safe for our applications, the Group has decided to use a GIDEP Problem Advisory.
- Describe Problem Advisory, how it works.

- In this case, the Group will include an attachment to the advisory of a list of questions that seek information that would help determine if our current PCTFE is safe for use.

- Although these questions are mainly to solicit answers from the material manufacturers, they are stated in a way that invites input from any GIDEP member that may have information that would help reach a solution.

- So, if the Group is seeking specific information from the GIDEP community, why did they not use an Urgent Data Request?

- If you're not familiar with what a UDR is, it is basically a way to quickly query the GIDEP community for specific information.

- Although the UDR has many advantages, such as Quick Dissemination to the GIDEP members and it is set up so that specific questions may be asked, for this particular situation, it had some Drawbacks.

    - UDR not made to include a Problem Description, like a Problem Advisory is made to have.

    - Even though responses are eventually documented in the GIDEP database, they are not disseminated back to the community.

    - With a Problem Advisory, if a solution is found, the advisory can be amended to include this information, which would then be re-distributed to all of the GIDEP community to help those who may be have been impacted by the issue as well.

Current Status

- Next, I'll talk about the current status of the 5 solution approaches and of the Problem Advisory.

- Most of the solution approaches have made much progress, and one is under the consideration of the working group.

- I'll first go over #2 - #5, and then come back to #1.
    - # 2 – ANNEALING – a set of Neoflon parts have undergone annealing tests, and we are just waiting for the results.
    - # 3 – SPECIFICATION – a test plan is currently in work to help facilitate the generation of a specification.
    - # 4 – PREVENTATIVE MAINTENANCE – the interim solution suggested is currently under consideration, but has not yet been implemented.
    - # 5 – REPLACEMENT MATERIAL - Candidate alternate materials have been found, but must undergo testing to verify its safe operations. Search continues towards finding additional candidates.
    - # 1 – PROBLEM ADVISORY
        - Draft was started back in late January
        - Undergone many revisions through the input of many Working Group members
        - At a point, momentum slowed in finalizing it because some data had to be verified.
        - Due to this, questions to vendors were sent out separately ahead of the advisory via email.
        - But, hardly any responses had been received.
        - Completion/submission date to GIDEP ***~ is estimated to be TBD OR was TBD***.
        - Expect vendor responses within 15 days after distribution to them.

The Problem Advisory

- This slide is about the GIDEP Problem Advisory in general. I will touch on the benefits, and then go into a question we asked ourselves regarding "the finish line", will make some concluding remarks, and talk about the partnership we hope to establish with other industry members that may help us find a solution.

- The benefits of the Problem Advisory include
    - Problem Documentation
    - Visibility in an Industry/Government wide central database
    - Timeless quality – posting available for present users, but also for the future.
    - All of these would help avoid the "Urban Legend Effect"
        - This is the terminology we've used to describe a situation where an issue is identified and solved, without an "official" way or place to document the problem and its solution.
        - So, the essentially, the only repository of the problem and its solution would be the personnel who were involved with the effort at that time.
        - In time as the generation of workers cycles, perhaps only a few or none of the "original" personnel involved may be available.
        - If the issue were to re-surface (either in the Space Program or in other industries), and no formal documentation was kept, this issue would become what we term an "Urban Legend".

- At a point in time we asked ourselves, what if a solution is found before the advisory is submitted?
- We'd have the solution at that point, why bother posting the advisory?
- What if a solution is reached after posting but before responses/information is received from vendors/industry/government? Or, what if we receive responses that help in finding a solution?
- Should we leave the advisory as-is, or consider revising it to update it?

- In both cases, posting it or revising the posting would allow Problem & Solution Documentation. More - TBD

- Conclusion – TBD

- Our goal is to disseminate this information and solicit input for anyone who has information that may lead to a solution. So in essence, we would like to form partnerships in an effort to help each other solve a problem that impacts us.

As REFERENCE ONLY

KSC PROBLEM ADVISORY

1. NOMENCLATURE OF PART:	2. MANUFACTURER/MANUFACTURER ADDRESS:	3. PAGE 1 OF 2
Polychlorotrifluoroethylene (PCTFE) Component Properties	**See Block 11**	

4. PROCUREMENT SPECIFICATION:	5. CAGE CODE:	6. LOT/DATE CODE:
See Block 11	**N/A**	**N/A**

7. MANUFACTURE PART/MATERIAL NUMBER	8. SERIAL NUMBER:	9. REFERENCES:
See Block 11	**N/A**	**N/A**

GENERAL INFORMATION

This is a NASA Advisory issued in accordance with the requirements of NASA Procedures and Guidelines 8735.1, "Procedures for Exchanging Parts, Materials, and Safety Problem Data Utilizing NASA Advisories and the Government-Industry Data Exchange Program." For information concerning processing and actions required to be conducted in conjunction with this information, refer to your contract or NASA Procedures and Guidelines 8735.1.

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11. PROBLEM DESCRIPTION:

PCTFE (also commonly known as CTFE) plastic is widely used in aerospace hardware for rigid nonmetallic parts such as valve seats, fastener locking patches, and washers. Until 1991, all rigid PCTFE used in NASA programs was manufactured by 3M under the trade name Kel-F 81. Daikin Industries in Japan also manufactured rigid PCTFE under license from 3M. Daikin PCTFE is sold under the trade name Neoflon; two grades are available, M300 and M400.

3M stopped manufacturing Kel-F 81 in 1991, but continued selling PCTFE under this name until 1995. This PCTFE was purchased from Daikin Industries, but was required to meet the specifications for Kel-F 81, which allows a narrower property range than those for Neoflon PCTFE. After 1995, all rigid PCTFE sold in the United States was either old Kel-F 81 stock or Neoflon.

Despite the differences in specified properties, many component manufacturers have used Neoflon as a "drop-in" replacement for Kel-F 81 with the same part number. In several cases, replacements for Kel-F parts purchased by NASA and identified as Kel-F 81 or PCTFE in the vendor documentation have actually been Neoflon. KSC is finding that it can no longer trace whether parts identified on engineering drawings as Kel-F 81 have been replaced by Neoflon in ground support equipment (and possibly also flight hardware).

Recent studies have shown that Neoflon PCTFE may have relatively poor dimensional stability, with as much as 8 percent shrinkage on heating to moderate temperatures, unless it is annealed before use. Dimensional changes are seen on heating to 40-60 °C, well below the typical specification maximum use temperature of 200 °C. Annealing is required by the current AMS specifications for rigid PCTFE, but has not been required by any of the other commonly used industry and government specifications. In addition, machining operations on Neoflon PCTFE that was annealed after manufacturing appear to reintroduce the dimensional instability, so depending on the extent of machining and part size, annealing may be truly effective only if it is conducted after machining.

The data on dimensional instability of the original Kel-F 81 PCTFE are currently too limited for us to determine whether this dimensional instability was the same for Kel-F 81 (and, therefore, factored into the original design and certification) or not. Tests on the limited remaining stocks of Kel-F 81 have shown rather better stability, but this may be the result of special treatment by a limited subset of PCTFE molding companies. Rocketdyne was sufficiently concerned about the dimensional stability of the original Kel-F 81 that they issued a custom procurement specification, RB0130-094, (which includes annealing and dimensional stability) for SSME components as far back as 1980 and certified only two vendors as meeting this specification (PCTFE components manufactured to this specification may be molded from Kel-F 81or Neoflon M400).

12. ACTION TAKEN:

KSC will conduct a stock sweep to identify and remove all PCTFE parts purchased since 1991. These parts may still be used, but must be evaluated on a case-by-case basis. New procurements of PCTFE should require that the vendor specify the raw material as being Kel-F 81, Neoflon M400, or Neoflon M300. A new procurement specification is in the early stages of development; in the interim, it is recommended that component requirements include PCTFE molding and/or part annealing, and verification of dimensional stability be included for all new PCTFE procurements. An example of a dimensional stability requirement is contained in AMS 3645C and AMS 3650C, however, it should be noted that no provision is made in these documents for annealing of finished parts or testing to verify stability unless ordered.

(Continued on Page 2)

13. NAME/TITLE OF ORIGINATOR:	14. ORIGINATOR PHONE NUMBER:	15. ORIGINATOR ADVISORY NUMBER:	16. DATE PREPARED:
Robert F. Speece/ PH-H2	**321-861-3637**	**N/A**	11/12/03

17. RELEASED BY: (SIGNATURE)	18. KSC ADVISORY COORDINATOR:	19. NASA/KSC ADVISORY NUMBER:
Original Signed By: *(Jeannette Lockman)*	Jeanette Lockman, KSC GIDEP Alert Coordinator TA-C1, Phone: (321) 867- 7570, Fax (321) 867-1120 E-mail: LockmJR@kscems.ksc.nasa.gov	NA-KSC-2003-001

KSC FORM 20-196

12. ACTION TAKEN

For most applications the slight difference between these polymers is insignificant. However, Kel-F 81 is frequently used in critical systems such as high-pressure oxygen, and the effects of such changes need to be assessed. Batch/lot testing using the standard NASA mechanical impact test per NASA-STD-6001 has not identified any significant difference in oxygen compatibility between Kel-F 81 and Neoflon.

However, dimensional instability can result in leakage (internal) and/or ignition by the poorly understood mechanism known as "flow friction", so Neoflon may have inferior oxygen compatibility at high pressures (flow friction ignition has not been observed below 1800 (Reference ASTM G04 Committee Workshop report dated 3-12-02 "Review of Fire Incident History with fluorinated and chlorinated polymers") and is not considered credible at 1050 psi and below).

Additional work is in progress to assess whether the dimensional stability of Neoflon is truly inferior to that of Kel-F 81, regardless of supplier and whether this thermal instability can result in the loss of the secondary locking feature in fasteners with PCTFE locking patches. For fluid systems with PCTFE parts, where flow-friction ignition is not credible and some small loss of reliability is tolerable, the continued use of Neoflon PCTFE that has been installed in place of Kel-F 81 is probably acceptable.

In parallel with the stock sweep effort, fluid systems that contain PCTFE have been identified and will be evaluated/accessed for possible flow-friction heating safety impacts. The order of fluid system assessment will be as outlined below.

- Systems of High Concern (Systems where failure is assessed as a Red on the SFOC Risk Assessment Scorecard)
  - High Pressure Oxygen Systems (Score 15-Red, Likelihood 3, Consequence 5-Safety)
  - High Flow Oxygen Systems (Score 15-Red, Likelihood 3, Consequence 5-Safety)

- Systems of Low Concern (Systems where failure is assessed as a Yellow on the SFOC Risk Assessment Scorecard)
  - High Pressure/High Flow Toxic or Flammable (Hypergols, Hydrogen, etc,) Gas Systems (Score 9-Yellow, Likelihood 3, Consequence 3-Safety)

- Systems of No Concern (Systems where failure is assessed as a Green on the SFOC Risk Assessment Scorecard)
  - Inert (GN2, GHe, etc,) Gas systems (For High Pressure GHe the Joule-Thompson effect, upon expansion from 6000 psi to ambient pressure, can lead to temperature increases of ~40 deg F. This can, considering the dimensional changes, lead to internal seat leakages.
  - Low Pressure/Low Flow Gas (Breathing Air, Compressed Air, etc,) and oxygen systems (1050 psi and below)
  - Liquid (Water, Hydraulic, etc,) ground support systems
  - Cryogenic Liquid (Hydrogen Oxygen, etc,) ground support systems

References to Past and Current Industry and Government Specification:

1. AMS 3645
2. AMS 3646
3. AMS 3650
4. ASTM D1430
5. MIL-P-21470
6. L-P-385
7. MIL-P-46036
8. MIL-P-55028

For additional technical information, please contact Dr. Harold Beeson of the NASA JSC White Sands Test Facility (e-mail Harold.d.beeson@nasa.gov; phone (505) 524-5542)

** TX CONFIRMATION REPORT ** AS OF APR 27 '04 11:07 PAGE.01

KSC-TA-E1

	DATE	TIME	TO/FROM	MODE	MIN/SEC	PGS	CMD#	STATUS
09	04/27	11:06	321 264 8224	EC--S	00'49"	002		OK