



Langley Management System Directive Review Summary

DOCUMENT INFORMATION		
Doc. No.	Title	Organization
LPR 5310.1	Foreign Object Damage (FOD) Prevention Program	SMAO (C2)

ACTION REQUEST		REVIEW PERIOD: July 20-31, 2015
Action	Summary of Changes	
<input checked="" type="checkbox"/> Revision/Review <input type="checkbox"/> New Document	<ol style="list-style-type: none"> 1. Mandatory 5-year review 2. Added Chapter 5 to specifically address Wind Tunnel requirements, and updated to omit Quality Assurance Branch. 3. Updates throughout for formatting, citations, titles, etc. 	

Reviews are handled according to CP 1410.2, Langley Management System Document Control.
When commenting on drafts or revisions, please cite specific sections and page numbers when possible.

REVIEW/CONCURRENCE SUMMARY	CONCURRENCE PERIOD: Aug. 24-Sept. 4, 2015
Reviewer	Review Comments
Shawn Gallagher	<ol style="list-style-type: none"> 1. As a general comment the numbering of the provisions is not consistent within the document or even the chapter. As an example, sometimes paragraph numbering goes out to five digits, i.e. 3.2.3.7.3 then goes to letters, i.e. a., b., and so forth. Other times numbering only goes to four digits, i.e. 3.2.3.10 then goes to letters a., b., and so forth. There are even times numbering only goes to three digits, i.e. 2.5.1 or 2.7.1 then goes to letters. In chapter 4, lettering begins after only two digits, i.e. 4.2 then it goes to letters. Recommend the document be reviewed and a consistent provision numbering system be applied throughout. Non-concur – <i>The numbering system used is in accordance to NPR 1400.1G, "NASA Directives and Charters Procedural Requirements", Section 3.7.3, h.</i> 2. Page 1, P.3, paragraph a, spell out NPD for this first use of the acronym. Concur 3. Page 1, P.3, paragraph b, spell out LAPD for this first use of the acronym. Concur 4. Page 1, P.4, paragraph b, spell out NPR for this first use of the acronym. Concur 5. Page 1, P.4, paragraph d, spell out LPR for this first use of the acronym. Concur 6. Page 1, P.4, paragraph f, spell out LMS-TD for this first use of the acronym, e.g. "Langley Management System - Technical Directive (LMS-TD)-0940." I am not 100% sure the "D" in TD stands for "Directive" so please insert the proper word. <i>(Directives Mgt. Note: Should be "Task Description")</i> Concur – <i>per Directives Management note.</i> 7. Page 1, P.4, paragraph f, the actual title is "Langley Research Center General Aircraft Maintenance Manual for Research Services Directorate (RSD)." Since we are citing the title, it is suggested "LaRC" be spelled out, see P.4 paragraph d even though we defined 8. LaRC in P.1 paragraph a. Concur 9. Page 2, P.4, paragraph l, suggest adding "International" after "SAE" as that is the organization's name. SAE does not need to be defined as the actual name of the organization is "SAE International." Concur 10. Page 2, P.5, paragraph a, line 2, suggest replacing "foreign object" with "FO" as that was defined at P.4, paragraph i. Concur
Org	
OCC	
Concurrence Response	
Choose an item.	



Langley Management System Directive Review Summary

	<p>11. Page 4, paragraph 1.1, since this is the text of the LPR proper, we can restart defining acronyms again. I will treat all subsequent acronyms similarly. Concur</p> <p>12. Page 4, paragraph 1.3, last line, per comment 11, define "LaRC." Concur</p> <p>13. Page 5, paragraph 2.1, the paragraph numbering is inconsistent with other sections. Suggest that "The FOD Program Manager shall:" language be pulled up to 2.1 after the title. The subparagraph a - h would then become 2.1.1 -2.1.8. See comment 15, below regarding 2.1.1e(1). Non-concur – <i>The numbering system used is in accordance to NPR 1400.1G, "NASA Directives and Charters Procedural Requirements", Section 3.7.3, h.</i></p> <p>14. Page 5, paragraph 2.1.1 b, define "LPR." Also "Center LPR" is redundant so suggest the word "Center" be deleted. Concur</p> <p>15. Page 5, paragraph 2.1.1 e(1), recommend deleting the "(1)" and placing the single sentence of the provision as an additional sentence in 2.1.1 e. Setting up a single subparagraph is almost always unwarranted. Concur</p> <p>16. Page 5, paragraph 2.1.1 e(1), per comment 11, above, define LF as this is the first usage in the LPR proper. Concur</p> <p>17. Page 5, paragraph 2.2.2, revise "(see chapter 3.1.1)" to "(see paragraph 3.1.1)." Same for paragraph 2.2.3. Concur</p> <p>18. Page 6, paragraph 2.2.6, revise "(see chapter 3.2.1)" to "(see paragraph 3.2.1)." Concur</p> <p>19. Page 6, subparagraph 2.2.6.1, recommend pulling the sentence up into 2.2.6. Setting up a single subparagraph is almost always unwarranted. Non-concur – <i>The numbering system used is in accordance to NPR 1400.1G, Section 3.1.1, e.</i></p> <p>20. Page 6, paragraph 2.2.12, SMAO was defined at page 5, paragraph 2.1.1 a. Concur</p> <p>21. Page 7, paragraph 2.3, suggest pulling the words at 2.3.1 up after the title. Paragraphs a-e would become 2.3.1 through 2.3.5. Non-concur – <i>The numbering system used is in accordance to NPR 1400.1G, Section 3.7.3, h.</i></p> <p>22. Page 7, paragraph 2.3.1 e, change "section 4.0" to "Chapter 4.0." Concur</p> <p>23. Page 7, paragraph 2.4, "Mission Assurance Branch" was defined at 2.1.1 f. Concur</p> <p>24. Page 7, paragraph 2.4.1, "Mission Assurance Branch" was defined at 2.1.1 f. Concur</p> <p>25. Page 7, paragraphs 2.4.1.2 through 2.4.1.5 (both of the paragraphs numbered 2.4.1.5) should be renumbered as 2.4.2 through 2.4.6. Concur</p> <p>26. Page 7, paragraph 2.4.1.4a should be drawn up into the body of 2.4.1.4. It would read "MAB personnel shall inspect for FO and FOD." I note there are no other subparagraphs under 2.4.1.4. Concur</p> <p>27. Page 8, paragraph 2.4.1.5 (the first one) probably should add "MAB personnel shall" before "Ensure FOD controls" The word ensure should not be capitalized if the addition is made. Concur</p> <p>28. Page 8, paragraph 2.4.1.5a and b, should become 2.4.6.1 and 2.4.6.2. At the end of subparagraph a there should be a semi-colon and an "and" or an "or" depending on what is intended. I believe what is intended is "and." Concur</p>
--	---



Langley Management System Directive Review Summary

	<p>29. Page 8, suggest pulling the words at 2.5.1 up after the title. Paragraphs a-g would become 2.5.1 through 2.5.7. Subparagraph 2.5.1 c(1) should be pulled up into 2.5.1c. Non-concur – <i>The numbering system used is in accordance to NPR 1400.1G, Section 3.7.3, h.</i></p> <p>30. Page 8, paragraph 2.6, you define Facility Safety Head as FSH, however, you spelled out Facility Safety Head at 2.1.1a; 2.2.12; 2.2.13; 2.2.14; and 2.2.15. If you want to utilize the acronym suggest you first do it at paragraph 2.1.1.a and utilize the acronym at the other locations. If you want to set it out in full text in 2.6 as a title that is acceptable or you could just use the acronym. At 2.6.1 you again set out "Facility Safety Head (FSH)" which is unnecessary as you did it at 2.6, and if you use my recommendation, 2.1.1a. Concur</p> <p>31. Page 8, paragraph 2.6.1, line 3, change "chapter 3.1.1" to "paragraph 3.1.1" or "see 3.1.1." Concur</p> <p>32. Page 9, paragraph 2.6.3, suggest using the acronym FSH instead of spelling out the title. Concur</p> <p>33. Page 9, paragraph 2.6.3, line 3, change "section 2.2.15" to "paragraph 2.2.15" or "see 2.2.15." Concur</p> <p>34. Page 9, below paragraph 2.7.1c, it appears the stray sentence "The supervisor shall keep records of FOD inspection checklists" should be drawn up into 2.7.1c. Concur - <i>The sentence was moved to its proper place as paragraph 2.6.5.</i></p> <p>35. Page 9, subparagraph 2.7.1e, change "section 3.1.3" to "paragraph 3.1.3" or "see 3.1.3." Concur</p> <p>36. Page 9, paragraph 2.7.4, the second line is indented when it should not be. Concur</p> <p>37. Page 10, I note that 3.1 is "General" and 3.1.2 is "General Guidance." That makes little sense. Consequently, recommend paragraphs 3.1 through 3.1.1.1.1 be revised as follows: Concur- <i>Revisions to context of language were made. However, numbering changes were made in accordance to NPR 1400.1G, Section 3.7.3, h.</i></p> <p>3.1 FOD Area Designation. FOD-sensitive areas shall receive a designation based on the risk associated with a FO, for the activities being performed in the area. The risk shall take into account both the consequences and probability a FO will not be found/controlled. (Most areas of the Center will be Non-FOD-Sensitive and will not need any FOD designation or any FOD control measures). Following that methodology, paragraph 3.1.1.2 would become 3.1.1 and a-d become 3.1.1.1 through 3.1.1.4. Paragraph 3.1.1.3 would become 3.1.2. It is suggested paragraphs 3.1.1.3 through be 3.1.1.3.2 be revised as follows:</p> <p>3.1.2 To determine the consequences, the following question should be answered: If a FO is not found/controlled, what is the worst-case scenario? Three examples are provided below:"</p> <p>3.1.2.1 Contamination causing loss of a multi-million dollar spacecraft should be considered catastrophic;</p> <p>3.1.2.2 Contamination resulting in the need to repeat a low cost experiment may be considered minimal; and</p> <p>3.1.2.3 The consequences of a FO impacting a wind-tunnel fan blade may lie between minimal and catastrophic, depending on the monetary loss expected and the programmatic impact.</p> <p>3.1.1.4 would become 3.1.3 and a-c would become 3.1.3.1 - 3.1.3.3. Suggest the wording be revised as follows:</p> <p>3.1.3 Some factors to be considered when determining the probability a FO will not be detected and successfully removed are set out in 3.1.3.1 through 3.1.3.3, below. (Evaluation of factor 3.1.3.1 is a judgment call that can vary from low to high depending on several parameters, such as the lighting during the inspection,</p>
--	--



Langley Management System Directive Review Summary

	<p>the number of additional times inspection will occur, the number of locations for a FO to "hide," and the physical ease of conducting an inspection. Factor 3.1.3.2 should be evaluated at the high end of the probability axis if answered as susceptible or highly susceptible and factor 3.1.3.3 should be similarly evaluated if answered in the affirmative.)</p> <p>3.1.3.1 Can a FO be found easily during planned future inspections? <i>Theoretically yes, especially if the planned inspections are developed with the specific FOD area or product in mind. For example, planned wind tunnel walk down inspections should find loose objects or objects that do not belong in the wind tunnel circuit. We had one instance years ago, where a small stool on wheels was left in a tunnel from working on the model. Other instances can be tools, smaller items like fasteners or even damaged wind tunnel "walls" or screens" (even though we have adjusted the definition in this revision to not include part of the wind tunnel that make be damaged or loose as "foreign objects." Other FO for aircraft can be items on a runway, and/or tools from working on engines or other areas of the aircraft. Harder to detect FO's are the smaller items that can end up inside of an enclosure, like an electronics box. There, much smaller items pose threats to the function of the box, either from a chemical contamination issue, an electrical short potential or if sufficient mass, damage from a loose item accelerating during launch. Obviously, FO of a smaller nature or in an area where areas hidden from direct line of sight make the inspection process more difficult.</i></p> <p>3.1.3.2 How susceptible is the product/hardware to damage by a dropped object or tool? - <i>This is entirely determined by the product/hardware, the weight of the dropped object, the height dropped, and the potential strike area. There are too many different scenarios to consider to give one definitive answer. However, it is an area of concern and needs to be considered when working on hardware, especially if there are "heights" involved. This is a more typical scenario in space flight work on rockets where platforms and scaffolding are involved. Here, perhaps some areas of wind tunnels and when on top of aircraft.</i></p> <p>3.1.3.3 Is the activity being performed a final close-out inspection of a payload? <i>-It can be, but the wording you used is interesting. One of the difficulties of this particular document, is, that it is supposed to cover the entire Center, where you have aircraft, wind tunnels, fabrication and spaceflight assembly and testing. Usually, there is no "final close-out inspection" of a payload per se. When a payload is "done", it is usually too late to look for the usual types of FO for a payload, although I guess, tools and the like could be left on external surfaces, but wouldn't be likely. Most FO inspections for payloads is intended to be done during the build-up and "close-out" of areas that can't be accessed later in the build process. Another close-out inspection involving a payload where FO should be looked for, would be when a payload goes into some type of enclosure like a rocket fairing.</i></p> <p>3.1.1.5 and 3.1.1.6 would become 3.1.4 and 3.1.5, respectively. Suggest 3.1.1.5 be revised as follows: 3.1.4 Figure 3.1, the examples at 3.1.2.1 through 3.1.2.3, and the factors under 3.1.3 of this LPR provide only qualitative guidance to assist a manager in making a final risk classification. 3.1.2 would become 3.1.6, and it is recommended 3.1.2.1 be combined into 3.1.2 and ended with a colon. 3.1.2.2 through 3.1.2.9 would become 3.1.6.1 through 3.1.6.8. 3.1.3 would become 3.1.7; 3.1.3.1 through 3.1.3.4 would become 3.1.7.1 through 3.1.7.4. Lettered and numbered subparagraphs a-e and c(1)-(2) (see comment 41 below) and d(1)-(5) would remain unchanged.</p> <p>38. Page 11, paragraph 3.1.1.6, SMAO was defined at page 5, paragraph 2.1.1a and FSH was defined at 2.6 and, if you use my recommendation, 2.1.1a. Concur</p> <p>39. Page 11, paragraph 3.1.2.4, line 2, suggest using the acronym FOD only instead of spelling out the title. See comment 54 regarding Appendix B, below. Concur</p> <p>40. Page 12, paragraph 3.1.3.1, lines one and three do not need quotation marks. Line 2, you can delete "Foreign Object (FO) or Foreign Object Damage (FOD)" and</p>
--	--



Langley Management System Directive Review Summary

	<p>replace with "FO or FOD". We have already defined FO and FOD and the quotation of the language indicates no particular authority or reason that makes the quotation authoritative. Concur</p> <p>41. Page 12, paragraph 3.1.3.4c, subparagraphs (1) and (2) should not be handled as subparagraphs. It would be clearer if 3.1.3.4c were revised substantially as follows: c. The supervisor and the Project Manager or Facility Safety Head determines a corrective action plan to prevent future occurrences. (Note a corrective action plan is not the direction necessary to remove the FO and restore the hardware. The details on directing how to remove the FO and restore the hardware are situational and should be handled on a case-by-case basis.) Concur</p> <p>42. Page 12-13, paragraph 3.1.3.4b, c, d(4), and e, suggest using the acronym FSH instead of spelling out the title. Concur</p> <p>43. Page 13, paragraph 3.2.1.5, line 2 "section 2.2.6 . . ." should be "paragraph 2.2.6 . . ." or "see 2.2.6" Concur</p> <p>44. Page 13, paragraph 3.2.1.7.1, recommend this be combined into 3.2.1.7 as it is an example of what has just been required by 3.2.1.7. Also, "(SFAB)" can be deleted as it is never used again in the LPR. Concur</p> <p>45. Page 15, paragraph 3.2.3.7.3 should be moved up and made a part of 3.2.3.7.2 as that provision gives context to the concept of "consideration" set out in 3.2.3.7.3. Concur- <i>However, numbering changes were made in accordance to NPR 1400.1G, Section 3.7.3, h</i></p> <p>46. Page 18, recommend paragraph 3.2.10.1 be combined with 3.2.10 as the information being conveyed is in 3.2.10.1 and 3.2.10 is just a title. There is no sense to arbitrarily assigning a separate paragraph designation for virtually every sentence. Concur</p> <p>47. Page 20, paragraph 5.1.2.1, "Langley Form (LF)" can be replaced with "LF" if the recommendation at comment 16, above, is adopted. I note there is a lot of usage of LF in chapter 3 so defining the term in chapter 5 is late. Concur</p> <p>48. Page 20, paragraph 5.2, delete "Foreign Object (FO) and Foreign Object Damage (FOD)" and replace with "FO and FOD" as these terms were previously defined. Concur</p> <p>49. Page 20, paragraph 5.2.1a needs alignment with the other provisions. Concur</p> <p>50. Page 20, paragraph 5.2.1b, subparagraphs (3) through (6) should be renumbered as (1) through (4) or the missing entries for (1) and (2) inserted before (3). Concur</p> <p>51. Page 20, paragraph 5.2.1 b(3), SMAO was defined at page 5, paragraph 2.1.1 a. Concur</p> <p>52. Page 21, paragraph A.5, line 5, there is a list of "flight hardware" being provided then the words "also be on risk reduction flights" occurs. This appears to be missing some words or is garbled as it is not "flight hardware." We might want to think about breaking the list into two or three sentences. The "also" would indicate we might be changing the types of flight hardware, but it is not clear. Concur - <i>I agree with the suggested change. It is clear-"er" without "also be on". This sentence was mangled when taken from LPR 5300.1, which read "SMAO requirements must "also be met on risk reduction flights, flight experiments,..." When used in that sentence, it was grammatically "better". The "also" in 5300.1 was meant, in context, that the first string of "project types"... most if not everyone understood that those are included. The also, was a historical leftover, because many years ago, a lot of folks would dodge requirements, because they would say we aren't "spaceflight."</i></p>
--	---



Langley Management System Directive Review Summary

	<p>53. Page 21, paragraphs A.6, A.7, and A.8, recommend you utilize the acronyms instead of spelling out the term and defining the acronym again. Because these are in an appendix they are acceptable as currently written. Same page 22, A.9-A.13. Concur</p> <p>54. Page 23, Appendix B, title, recommend you utilize the acronym FOD instead of spelling out the term. Concur</p>
Concurrence Date	Owner Response
1/8/2016	Owner's responses provided in "Review Comments" section above.

Reviewer	Review Comments	
Sam Motley	<ol style="list-style-type: none"> 1. Page 5 of 23, paragraph 2.1.1.g. Suggest changing "Arbitrates" to "Arbitrate" Concur 2. Page 5 of 23, paragraph 2.1.1.h. Suggest changing "Performs" to "Perform" Concur 3. Page 5 of 23, paragraph 2.2.3 Suggest changing "the proper level" to "the assigned level" Concur 4. Page 8 of 23, paragraph 2.4.1.5 This paragraph starts with "Ensure" - does that mean it is part of 2.4.1.4's shall, which would make it 2.4.1.4.b? If not, it seems like the lead in should start with the party that will ensure FOD controls are followed. Concur 5. Page 8 of 23, paragraph 2.6.2 Where it says "If a FO and/or FOD is found, and a Project Manager is not assigned, work with the", suggest clarifying to read "If a FO and/or FOD is found, and a Project Manager is not assigned, the FSH shall work with the" Page 10 of 23, paragraph 3.1.1.1.1 Suggest changing "The risk shall" to "The risk assessment shall" Concur 6. Page 11 of 23, paragraph 3.1.1.6 I think we have already spelled out the acronym for FSH so it seems like "Facility Safety Head" can be removed from this sentence. Same with "Safety and Mission Assurance Office" which is spelled out earlier in the document. Concur 7. Page 17 of 23, paragraph 3.2.8.3.g. Suggest changing "assure" to "ensure" in line 2 - Concur 	
Org		
OCFO		
Concurrence Response		
Choose an item.		
		Sam Motley/OCFO - 864-2180
Concurrence Date		Owner Response
1/8/2016	Owner's responses provided in "Review Comments" section above.	



Langley Procedural Requirements

LPR 5310.1 C
Effective Date:
Expiration Date:

Subject: Foreign Object Damage (FOD) Prevention Program

Responsible Office: Safety and Mission Assurance Office

PREFACE

P.1 PURPOSE

- a. This Langley Procedural Requirements (LPR) sets forth roles and responsibilities and procedural requirements for the Langley Research Center (LaRC) Foreign Object Damage (FOD) Prevention Program.
- b. The purpose of the FOD Prevention Program is to prevent injury to personnel and/or prevent damage to critical hardware, experiments, systems, aircraft and facilities through proper classification of FOD areas, training of personnel and implementing appropriate FOD prevention and detection techniques.

P.2 APPLICABILITY

- a. The LaRC FOD Prevention Program applies to all personnel performing fabrication, assembly, maintenance, operations and inspection on LaRC aircraft, models, tunnels, facilities and flight hardware for Center Projects where FOD can potentially cause damage or loss of mission success.
- b. The program shall be used for operations both at LaRC and away from Center.

P.3 AUTHORITY

- a. [NASA Policy Directive \(NPD\)](#) 8730.5, NASA Quality Assurance Program Policy
- b. [Langley Policy Directive \(LAPD\)](#) 1700.1, Safety Program
- c. LAPD 5300.1, Program/Product Assurance

P.4 APPLICABLE DOCUMENTS AND FORMS

- a. NPD 8700.1, NASA Policy for Safety and Mission Success
- b. [NPRNASA Procedural Requirements \(NPR\)](#) 8715.3, NASA General Safety Program Requirements
- c. NPD 8730.5, NASA Quality Assurance Program Policy
- d. [LPRLangley Procedural Requirements \(LPR\)](#) 1440.7, Langley Research Center (LaRC) Records Management Procedural Requirements
- e. LPR 1710.12, Potentially Hazardous Materials - Hazard Communication Standard

- f. [Langley Management System - Task Description \(LMS-TD\) -0940](#), [LaRC Langley Research Center](#) General Aircraft Maintenance Manual for [Research Services Directorate \(RSD\)](#).
- g. LMS-TD-8735, Housekeeping Instruction for the Fabrication of Foreign Object Debris (FOD) Free Products in the Fabrication Facilities
- h. Langley Form (LF) 164, Report of LaRC Safety/Health Concern/Close Call
- i. LF 360, Foreign Object (FO) and Foreign Object Damage (FOD) Incident Report
- j. LF 361, FOD Prevention Survey Checklist
- k. National Aerospace FOD Prevention, Inc., "FOD Prevention Guideline"
- l. Quality Management System SAE [International](#) Aerospace Standard AS9100

P.5 MEASUREMENT/VERIFICATION

Compliance with this LPR is verified through responses to the following questions:

- a. Do Organizational Units have the applicable processes in place that include provisions for the prevention, detection, and removal of ~~foreign object~~[FO](#) debris?
- b. Are inspections conducted against procedural requirements?
- c. Do Organizational Units maintain and verify records of FOD prevention training, incidents, and corrective actions?

P.6 CANCELLATION

LPR 5310.1, dated September 2, 2011

DISTRIBUTION:

Approved for public release via the Langley Management System; distribution is unlimited.

Contents

PREFACE	1
P.1 PURPOSE.....	1
P.2 APPLICABILITY	1
P.3 AUTHORITY.....	1
P.4 APPLICABLE DOCUMENTS AND FORMS.....	1
P.5 MEASUREMENT/VERIFICATION.....	2
P.6 CANCELLATION.....	2
CHAPTER 1: Introduction	4
CHAPTER 2: Roles and Responsibilities	5
2.1 FOD Program Manager.....	5
2.2 Management of Areas Where FOD is a Concern.....	5
2.3 Project Management	7
2.4 Mission Assurance Branch (MAB)	7
2.5 FOD Representatives	8
2.6 Facility Safety Head (FSH)	8
2.7 Employees	9
CHAPTER 3: FOD Control Requirements	10
3.1 FOD Area Designation	10
3.2 General Guidance	131
3.3 FO and FOD Incident Reporting	102
3.4 Implementation and Control Methods	13
CHAPTER 4: Design Considerations	19
CHAPTER 5: Guidelines for Wind Tunnels	20
5.1 Domestic Items.....	20
5.2 Reporting of a FO and FOD.....	20
APPENDIX A: Definitions	21
APPENDIX B: FOD Areas	23

CHAPTER 1: Introduction

1.1 A Foreign Object (FO) is defined as a substance, debris or article alien to hardware or system which could potentially cause damage. The object may be foreign to an area or system and may be ingested by, or lodged in a mechanism. Foreign Object Damage (FOD) is defined as any damage attributed to a FO that can be expressed in physical or economic terms, which may or may not degrade the product's required safety and/or performance characteristics. Some examples of how a FO causes damage include ingestion of loose hardware by an aircraft engine or passing debris through wind tunnel blades, short circuiting of flight electronics, contamination of sensors and optics, mechanisms that fail to operate properly and chemical attack on the physical properties of materials.

1.2 Most FOD can be attributed to poor housekeeping, facilities deterioration, improper maintenance or careless assembly, not keeping full account of hardware, tools and materials, and inadequate operational practices. An effective FOD prevention program identifies potential problems, corrects negative factors, provides awareness, effective employee training, and uses industry "lessons learned" for continued improvement. LaRC management is committed to strive for excellence in the conduct of operations to ensure the quality and safety of products and services. Quality Systems such as AS9100 require FO and FOD to be addressed and many LaRC Projects are required to meet AS9100 requirements. Organizational planning and function shall include provisions for the prevention, detection, and removal of FOs in FOD-sensitive areas.

1.3 The requirements contained in this document describe the provisions that shall be followed to ensure the development, implementation, verification and continuous improvement of a sound FOD Prevention Program at [Langley Research Center \(LaRC-\)](#).

CHAPTER 2: Roles and Responsibilities

2.1 FOD Program Manager

2.1.1 The FOD Program Manager shall:

- a. Oversee LaRC's FOD Program by interfacing with Managers, Project Managers, Quality Assurance, FOD Representatives Safety and Mission Assurance Office (SMAO) Facility System Safety Engineer, Facility Safety Heads ([FSHs](#)) and Employees working in FOD-sensitive areas.
- b. Update [Center Langley Procedural Requirements \(LPR\)](#) FOD prevention processes and procedures as needed.
- c. Provide FOD Representatives training on the FOD Prevention Program's content and changes, as needed.
- d. Provide general training materials, both for Center Awareness information and FOD Prevention Program content training.
- e. Conduct FOD Area assessments with FOD Representatives, by evaluating site-specific FOD Inspection Checklists, FOD/Tool Control Logs and FO and FOD Incident Reports. Assessment will also consist of sampling actual FOD-sensitive areas, using [Langley Form \(LF\)](#) 361 and/or other assessment tools/checklist(s).
- f. Record results of assessments into a yearly report and maintain in the Mission Assurance Branch (MAB) document library.
- g. [Arbitrates/Arbitrate](#) FO and FOD issues that aren't resolved at the supervisor/FOD Representative level.
- h. [Performs/Perform](#) continuous improvement activities for the FOD Prevention Program by staying abreast of changes/improvements in FOD Prevention Programs and techniques.

2.2 Management of Areas Where FOD is a Concern

2.2.1 Organizational Unit Managers (OUM) shall assign a FOD Representative(s) for their organization.

2.2.2 Branch Heads shall perform the risk assessments on all work areas to determine the proper level of FOD classification for each affected work area (see [chapter/paragraph 3.1.1](#)).

2.2.3 OUMs shall concur on risk assessments and the [proper/assigned](#) level of FOD sensitivity for each affected area (see [chapter/paragraph 3.1.1](#)).

2.2.4 Supervisors shall ensure that proper signage, consistent with the FOD-sensitive area, is posted in those areas.

2.2.5 Supervisors shall determine site specific FO and FOD control techniques as well as the frequency of any needed inspections (as determined by management) and include these in the appropriate facility or project documentation.

2.2.6 Supervisors shall ensure that all personnel with access to FOD-sensitive areas have the appropriate training and authorization to perform work in each respective area (see [chapter paragraph 3.2.1](#)).

2.2.6.1 Supervisors shall keep records of all FOD training.

2.2.7 Supervisors shall include any specific FO and FOD control techniques, procedures, documentation and inspections for their respective areas as part of the required training for personnel working in those areas

2.2.8 Supervisors shall ensure employees performing work in FOD-sensitive areas follow the assigned FO elimination policies and procedures for each designated area, including their normally assigned work stations.

2.2.9 Supervisors shall include reviewing FOD prevention compliance as an integral part of the monthly supervisory safety inspections.

2.2.10 Supervisors shall implement additional site-specific or project-specific requirements upon request by the customer (i.e., a customer can be someone who brings an item to a wind tunnel to be tested. A Project Manager is also considered a customer, if they go to the Fabrication Service Activity to have something built for a project.)

2.2.11 Branch Heads and Supervisors shall ensure implementation of corrective actions relating to FO prevention, detection, and removal throughout the organization.

2.2.12 Supervisors shall inform the FOD Representative, FOD Program Manager, [Safety and Mission Assurance Office \(SMAO\)](#) Facility System Safety Engineer, and [Facility Safety Head FSH](#) or Project Manager (as applicable) of any FO and/or FOD incident as soon as practical.

2.2.13 The Project Manager or [Facility Safety Head FSH](#) shall work with the supervisor in developing a corrective action plan.

2.2.14 After completing the corrective action portion of the LF 360, supervisors shall notify the FOD Representative, FOD Program Manager, SMAO Facility System Safety Engineer, and [Facility Safety Head FSH](#) or Project Manager (as applicable).

2.2.15 Supervisors and the Project Manager or ~~Facility Safety Head~~[FSH](#) shall sign off Corrective Action Completed on the LF 360 after closure activities are performed. Corrective Action Plans are to be completed in a timely manner commensurate with the effort required.

2.2.16 Supervisors shall maintain records of site-specific FOD inspection checklists (see 2.2.5 and 2.2.7), LF 360, and LF 361 in a manner that the records are readily accessible to support audits and assessments.

2.2.17 Supervisors shall provide records requested by the FOD program manager during yearly FOD manager program assessments or other Center audits/assessments.

2.3 Project Management

2.3.1 The project management shall:

- a. Identify the proper FOD classification and requirements for the project in the appropriate documentation.
- b. When additional or enhanced procedures need to be implemented, ensure project-specific FOD requirements are provided to the appropriate implementing organization.
- c. Ensure all FO and FOD reported incidents are reviewed and that corrective actions are taken to prevent recurrence.
- d. Ensure all FO and FOD incident documents become part of the project work package and records.
- e. Include the design considerations for FOD control in ~~section~~[Chapter](#) 4.0 as a part of their system engineering approach.

2.4 ~~Mission Assurance Branch (MAB)~~

2.4.1 ~~Mission Assurance Branch~~[MAB](#) personnel support flight projects and their role with respect to FO and FOD is limited to such, and the facilities where the Project hardware is being processed (i.e., not involved in wind tunnels, aircraft or research facilities). MAB personnel shall include FO and FOD inspections during receipt inspection and quality assurance testing of safety critical products (LAPD 4520.1, “Langley Research Center (LaRC) Requirement for Safety-Critical Product Testing”).

2.4.2 MAB personnel shall ensure the appropriate FO and FOD requirements, controls and inspections are included in project work packages and procedures.

2.4.3 MAB personnel shall: [inspect for FO and FOD.](#)

~~a. Inspect for FO and FOD.~~

2.4.4 [MAB personnel shall](#) ensure FOD controls are being followed as part of general project quality assurance duties. QA personnel shall perform and sign off FOD inspections as required by any project documentation.

[2.4.1.5](#)—MAB and project personnel shall ensure all project FO and FOD incidents :

[a.](#)—are documented in the appropriate project problem reporting and corrective action system.

2.4.5 [i.](#) become part of the project work package or records.

2.5 FOD Representatives

2.5.1 FOD Representatives shall:

- a. Provide the FOD Program Manager a listing of all FOD-sensitive areas and their locations (building and room number) and any subsequent changes.
- b. Maintain the FOD-sensitive list for their responsible areas.
- c. Perform and document periodic assessments of the execution of the FOD Prevention Program in their respective organizations, using the LF 361.

(1) The supervisor shall keep records of LF 361s. A copy may be requested by the FOD Program Manager.

- d. Ensure that the FOD Program Manager has been notified, if any FO and FOD has been found, or of any other FO and FOD related issues, incidents or concerns.
- e. Ensure that the LF 360 corrective action plans are completed and report the status of the corrective action plans up the management chain as necessary.
- f. Provide support when requested by the FOD Program Manager during yearly FOD Manager Program assessments or other Center audits/assessments.
- g. Work with FOD Program Manager on reviewing and assessing the effectiveness of the organization's FOD prevention program.

2.6 ~~Facility Safety Head (FSH)~~

2.6.1 ~~Facility Safety Head (The~~ FSH) shall assist the Branch Head, when determining the risk associated with a FO for the activities being performed in an area, and the FOD sensitivity designation (see [chapter paragraph 3.1.1](#) for FOD Area Designation information).

2.6.2 If a FO and/or FOD is found, and a Project Manager is not assigned, [the FSH shall](#) work with the supervisor in developing a correction plan to be filled out on the LF 360.

2.6.3 Supervisors and the Project Manager or ~~Facility Safety Head~~[FSH](#) shall sign off Corrective Action Completed on the LF 360 after closure activities are performed (See [clauseparagraph](#) 2.2.15).

2.6.4 ~~2.6.4~~—The supervisor shall keep records of LF 360s.

~~2.6.5 The supervisor shall keep records of FOD inspection checklists.~~

2.7 Employees

2.7.1 ~~2.7.1~~—All personnel who work in FOD-sensitive areas shall:

- a. Be responsible for conducting work in a manner that provides for the prevention, detection and removal of FOs.
- b. Complete required FOD Prevention Program training designated by each organization.
- c. Perform scheduled walk-downs as determined by management using site-specific FOD Inspection Checklists (see 2.2.5 and 2.2.7).

~~The supervisor shall keep records of FOD inspection checklists.~~

d. Immediately report any FO and/or FOD that is found and any other FO and FOD related issues and concerns to their immediate supervisors and to FOD Representatives.

e. Fill out employee portion of the LF 360 or report in the NCR system for flight hardware (see [sectionparagraph](#) 3.1.3 - FO and FOD Incident Reporting), and forward it to their immediate supervisor.

2.7.2 ~~2.7.2~~—Employees shall obtain an effective understanding of FO and FOD policies and requirements for project-specific and site-specific work.

2.7.3 ~~2.7.3~~—Employees shall practice effective housekeeping techniques (see section 3.24.2.2) and a “clean-as-you-go” (see definitions, Appendix A) work ethic.

2.7.4 ~~2.7.4~~—Employees shall follow the requirements listed in the FOD control requirements, Chapter 3 of this LPR.

2.7.5 ~~2.7.5~~—Employees shall work with management to help develop specific inspections, control measures and techniques for FOD-sensitive areas.

CHAPTER 3: FOD Control Requirements

3.1 General

3.1.1 FOD Area Designation

3.1.1 FOD-sensitive areas shall receive a designation based on the risk associated with a FO, for the activities being performed in the area. (Most areas of the Center will be Non-FOD-Sensitive and will not need any FOD designation or any FOD control measures).

3.1.1.1 The risk assessment shall take into account both the consequences and probability a FO will not be found/ controlled.

3.1.2 3.1.1.2—Using Figure 3.1 as a guide for combining the two risk factors (i.e., consequence and probability), FOD-sensitive work areas shall be designated as follows:

- Non-FOD-Sensitive:** An area where the risk associated with a FO is negligible and no FOD control measures are needed.
- FOD Awareness Area:** An area where the risk associated with a FO resulting in hardware damage/contamination is low.
- FOD Control Area:** An area where the risk associated with a FO resulting in hardware damage/contamination is medium.
- FOD-Critical Area:** An area where the risk associated with a FO resulting in hardware damage/contamination is high.

3.1.3 To determine the consequences, the following question should be answered: If a FO is not found/controlled, what is the worst-case scenario?

3.1.3.1 ~~For example,~~ Contamination causing loss of a multi-million dollar spacecraft should be considered catastrophic, ~~whereas the consequences of,~~

~~3.1.3.13.1.3.2~~ Contamination resulting in the need to repeat a low cost experiment may be considered minimal—; and

3.1.3.23.1.3.3 The consequences of a FO impacting a wind-tunnel fan blade may lie between minimal and catastrophic, depending on the monetary loss expected and the programmatic impact.

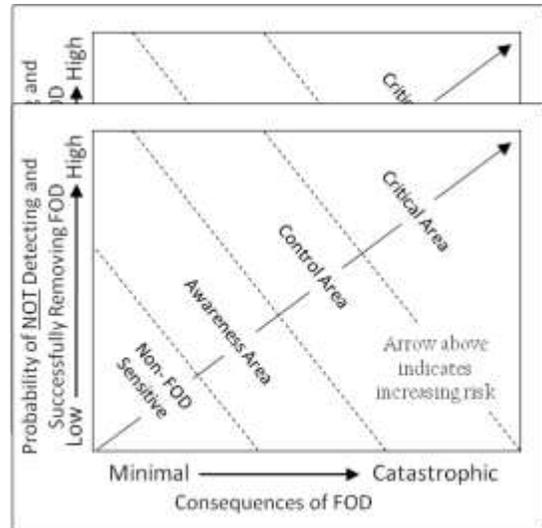


Figure 3.1: Guidance for combining risk factors (conceptual drawing)

3.1.4 Some factors to be considered when determining the probability a FO will not be detected and successfully removed are: set out in 3.1.4 a through 3.1.4 c below:

- a. Can a FO be found easily during planned future inspections?
- b. How susceptible is the product/hardware to damage by a dropped object or tool?
- c. Is the activity being performed a final close-out inspection of a payload?

~~(1) Factors 3.1.1.4.b and 3.1.1.4.c in this document should be evaluated at the high end of the probability axis.~~

~~*Note: Evaluation of factor one 3.1.4 a is a judgment call that can vary from low to high depending on several factors/parameters, such as the lighting during the inspection, the number of additional times inspection will occur, the number of locations for a FO to “hide,” and the physical ease of conducting an inspection.*~~

~~*Factor 3.1.4 b should be evaluated at the high end of the probability axis if answered as susceptible or highly susceptible and factor 3.1.4 c should be similarly evaluated if answered in the affirmative.*~~

3.1.5 Figure 3.1 ~~(found on page 11)~~, and the examples ~~in paragraph at~~ 3.1.4-3.1 ~~through 3.1.3.3, and the factors under 3.1.4 of~~ this ~~document~~ LPR provide only qualitative guidance to assist a manager in making a final risk classification.

3.1.6 For further assistance with determining the risk, consult with the area ~~Facility Safety Head (FSH)~~ or the FOD Program Manager in the ~~Safety and Mission Assurance Office (SMAO)~~.

~~3.2~~ ~~3.1.2~~ **General Guidance**

3.2.1 ~~3.1.2.1~~ — The following statements are provided to establish general control requirements for the primary purpose of preventing FOD to facilities, aircraft and quality-sensitive aerospace products being designed, developed, manufactured, assembled, operated, repaired, modified, refurbished and maintained.

3.2.2 Designated FOD-sensitive work areas shall be identified by management with proper signage to designate the level of sensitivity.

3.2.3 The level of FOD sensitivity in a given area, determined by management is subject to increase or decrease based on the sensitivity and criticality of the system or product being worked on at the time.

3.2.4 Controls for FOD-sensitive area levels shall be established using Appendix B, ~~Foreign Object Damage (FOD)~~ Areas, and section 3.24 of this LPR as guidance.

3.2.5 Personnel working in FOD-sensitive areas shall comply with the requirements for that level of sensitivity.

3.2.6 Personnel entering FOD-sensitive areas shall be held accountable for items carried into these areas.

3.2.7 Materials and parts received shall be checked and/or inspected for FO and FOD prior to use.

3.2.8 All visitors entering FOD-sensitive areas shall be trained or escorted by the FOD Representative or other FOD trained personnel, as determined by management consistent with the FOD classification area.

3.2.9 All tasks shall include the applicable level of provisions for the prevention, detection, and removal of FOs to ensure and preserve the conformity of product and service.

3.3 ~~3.1.3~~ FO and FOD Incident Reporting

3.3.1 ~~3.1.3.1~~ —For purposes of this document, an FO and FOD incident is defined as “an instance where a ~~Foreign Object (FO)~~ or ~~Foreign Object Damage (FOD)~~ is found in a FOD-sensitive area or product.”

3.3.2 FOD discovered prior to, during, or after final inspection is to be removed immediately if possible, and documented on the proper form. An LF 360 shall be used to document the discovery of FOs in FOD-sensitive areas or products, except for quality-sensitive/flight project hardware which is addressed below.

3.3.3 For flight hardware, the FO and/or FOD incident needs to be documented in the appropriate preventive and corrective action reporting system (i.e., NCR) prior to taking corrective action.

3.3.4 ~~3.1.3.4~~ —When an incident occurs related to non-flight hardware the following reporting requirements shall be followed:

- a. The employee that discovers the debris and/or damage shall notify their immediate supervisor and fill out an LF 360 and gives the LF 360 to his/her supervisor.
- b. The supervisor contacts/notifies the FOD Representative, FOD Program Manager, SMAO Facility System Safety Engineer, ~~and Facility Safety Head~~and FSH or Project Manager (as applicable) of the incident.
- c. The supervisor and the Project Manager or Facility Safety Head FSH determines a corrective action plan to prevent future occurrences.

The

Note: A corrective action plan is not the direction necessary to remove the FO and restore the hardware. The details on directing how to remove the FO ~~and~~ans restore the hardware are situational and should be handled on a case-by-case basis.

- d. After the corrective action plan has been specified on the LF 360, the supervisor shall notify the following persons as applicable:
- (1) FOD Representative
 - (2) FOD Program Manager
 - (3) SMAO Facility System Safety Engineer
 - ~~(4) Facility Safety Head~~
 - ~~(4) FSH~~
 - (5) Project Manager
- e. Upon completion of the corrective action plan, the supervisor and Project Manager or Facility Safety Head will close the LF 360 by signing the form. The supervisor will then maintain the LF 360 in the appropriate filing system.

3.4 ~~3.2~~ Implementation and Control Methods

3.4.1 ~~3.2.1~~ Training

3.4.1.1 ~~3.2.1.1~~ Employees directly involved with FOD-sensitive work shall receive the appropriate training prior to working in the area and on a biennial recurring basis thereafter, by the employee's management.

3.4.1.2 ~~3.2.1.2~~ Recurring training can be done more frequently if determined as a need by an organization's management.

3.4.1.3 ~~3.2.1.3~~ Training shall consist of briefing the FOD Prevention Program content to the employees and/or requiring the employees to read and understand the information contained in this LPR.

3.4.1.4 ~~3.2.1.4~~ The FOD Program Manager will provide briefing charts when requested, to provide clarification to FOD Prevention Program content.

3.4.1.5 ~~3.2.1.5~~ Any information, forms, procedures or inspections specific to the work and/or work site shall be included in the training (provided by management, see ~~section~~[paragraphs](#) 2.2.6 and 2.2.7).

3.4.1.6 ~~3.2.1.6~~ Organizations are responsible for training, and certifying employees and also maintaining training currency and records.

~~3.2.1.7~~ A general awareness of the FOD Prevention Program shall be provided to all employees.

3.4.1.7 ~~3.2.1.7.1~~ Examples of providing general awareness include using public outreach venues such as informational brochures and/or information found on the LaRC Center's Safety and Facility Assurance Branch ~~(SFAB)~~ Website located at <https://safety.larc.nasa.gov/>.

3.4.2 ~~3.2.2~~—Housekeeping

3.4.2.1 ~~3.2.2.1~~—Effective housekeeping standards shall be implemented and maintained by all employees in order to protect all personnel, products and facilities from FO and FOD.

3.4.2.2 ~~3.2.2.2~~—Employees shall:

- a. Incorporate “Clean-As-You-Go” as a required work ethic to prevent debris from migrating into FOD-sensitive areas and hardware.
- b. Ensure that all FOD-sensitive areas meet “good housekeeping” standards that enhance FO elimination. This includes sweeping and vacuuming production, wind tunnel, test cells and rigs, and model build-up areas. Appendix B lists some common housekeeping practices for the various FOD-sensitive areas.
- c. For Fabrication facilities, follow LMS-TD-8735.
- d. Maintain grounds and surfaces on which aircraft and ground support equipment are operated and maintained free of objects that could cause damage due to ingestion of FOs or jet blast effects per LMS-TD-0940.

3.4.3 ~~3.2.3~~—Material Handling and Parts Protection

3.4.3.1 Production and service operations shall include processes necessary to protect all products from FO and FOD.

3.4.3.2 Controlled conditions are to be established for material handling, including consumables, and parts protection in order to eliminate FO hazards as follows:

- a. Identify quality-sensitive parts, assemblies, surfaces, areas, etc. to be protected from FO and FOD.
- b. Evaluate cleanliness and care requirements.
- c. Sequence events for packaging, handling, shipping and storage.

3.4.3.3 All employees shall follow identification, tracking, packaging, handling, shipping, and storage requirements.

3.4.3.4 Materials and accessories used in the packaging, handling, shipping and storage, of parts or assemblies shall be clean and free of contamination.

3.4.3.5 Parts and assemblies shall be packaged in a manner that shall include provisions to prevent damage as a result of making contact with another object during normal handling and shipping operations.

3.4.3.6 Protective and packaging materials shall be chosen by Project Engineering based on their ability to adequately resist penetration by tearing, parting, or piercing from forces either external or internal during normal handling operations.

3.4.3.7 Protective devices (edge protectors, caps, plugs, covers, filters, rub strips) shall be cleaned and secured to prevent accidental damage.

3.4.3.7.1 Once installed, unauthorized removal of the protective devices is prohibited and shall be controlled through assembly or maintenance paperwork.

3.4.3.7.2 Consideration shall:

- a. Be given to the visibility and removal of material used for protection so that the material itself does not become a FO.

~~3.4.3.7.3~~ Consideration shall include:

- b. Include the color of packaging or protective devices so they don't appear to be a part of what they are protecting.
- c. Include streamers for removal for critical items.

3.4.3.8 Materials shall be compatible with the environmental and physical stresses expected to be encountered during product service.

3.4.3.9 Static-sensitive devices shall be properly protected to avoid damage. Materials used to protect electro-explosive devices and sensitive electronic components shall be kept clean, covered, and stored away from ordinary non-static safe materials.

3.4.3.10 MAB hardware, facility, or aircraft personnel shall visually inspect all packaging, handling, shipping and storage containers for the following:

- a. Nicks, dents, holes, abrasions, scratches, burns, etc., which may be detrimental to the function and integrity of the part or assembly.
- b. Grease, preservatives, corrosion products, weld slag, dirt, and other materials foreign to the item.

3.4.4 ~~3.2.4~~ Tool Accountability

3.4.4.1 ~~3.2.4.1~~ Tool accountability methods shall be maintained in FOD-sensitive areas based upon the level of risk.

3.4.4.2 ~~3.2.4.2~~ Recommendations include, but are not limited to:

- a. Use of shadow boards, shadowboxing, bar coding, special canvas layouts with tool pockets, tool counters, chit system tool tags, or consolidated tool kits.
- b. Unique control methods shall be implemented for special tools used in checkout, test and operational environments.
- c. Tools and equipment shall be tethered or suitably restrained to the user in FOD-sensitive areas where a dropped article could result in damage to flight project hardware, or where it would be difficult to retrieve a dropped tool.
- d. All loose tools shall be contained in a tote tray, soft tool bag or other suitable spill-proof container and not placed in a manner that would cause damage to flight project hardware.

3.4.5 ~~3.2.5~~ Hardware Accountability

3.4.5.1 ~~3.2.5.1~~ Hardware accountability methods shall be maintained in FOD-sensitive areas based upon the level of risk.

3.4.5.2 ~~3.2.5.2~~ Recommendations include, but are not limited to:

- a. Kit (package) hardware by task (nuts, bolts, screws, cotter pins, rivets, etc.):
- b. Proper disposal containers shall be placed near the work area.
- c. "Clean-As-You-Go" debris generated from hardware shall be properly monitored.
- d. Removal and installation documentation to track loose parts as required by project.
- e. Furnish and specify tote trays.
- f. Covered containers with spring-loaded mechanism or other device for securing lids.

3.4.6 ~~3.2.6~~ Lost Items

3.4.6.1 ~~3.2.6.1~~ Any time an item is lost in a FOD control or FOD-critical area:

- a. Activity shall be ceased in the affected area.
- b. Search for the item shall be initiated.

3.4.6.2 ~~3.2.6.2~~ A thorough search shall be continued until the item is found or adequate assurances are made that the item is not in the area.

3.4.6.3 ~~3.2.6.3~~ Searching for critical FOs or other items may require parts removal or nondestructive inspections.

3.4.6.4 ~~3.2.6.4~~ If an item cannot be located after an appropriate search has been conducted, facility/project management with concurrence from SMAO may allow activities to resume.

3.4.6.5 ~~3.2.6.5~~ Project-specific or site-specific rationale and/or operational constraints shall be developed and documented for any lost items and in the case of constraints, followed.

3.4.7 ~~3.2.7~~ Hazardous Material

3.4.7.1 ~~3.2.7.1~~ Management of hazardous materials and waste generated is important in the prevention of FOD.

3.4.7.2 ~~3.2.7.2~~ Disposition of hazardous waste materials is dependent upon the commodity discarded.

3.4.7.3 ~~3.2.7.3~~ Hazardous materials are to be managed in accordance with LPR 1710.12, "Potentially Hazardous Materials – Hazard Communication Standard."

3.4.8 ~~3.2.8~~ Assembly Operations

3.4.8.1 ~~3.2.8.1~~ Plan and sequence maintenance/manufacturing tasks to preclude FOD and entrapment of debris or contamination.

3.4.8.2 ~~3.2.8.2~~ Documents shall contain necessary processes and procedures for controlling and removal of contamination and debris during fabrication and assembly operations.

3.4.8.3 ~~3.2.8.3~~ As applicable, the following shall be included in work instructions:

- a. Upon completion of final machining operation, clean or flush the machined component to ~~assure~~ensure that it is free of debris. Protect exposed openings to prevent FO entry.
- b. Adequately protect hardware and equipment from splatter accumulation during brazing, soldering, welding, bonding, and like operations.
- c. Inspect components and equipment for damage prior to installation and repair as necessary. Always ensure part integrity before installation.

- d. Verify required protective devices (dust covers, temporary seals, cushioning, etc.) are present and properly installed. Items with protective devices missing are to be inspected for FO and FOD, cleaned (if necessary) and protective devices installed.
- e. After fluid and pneumatic system lines and tubing are cut and deburred, [assureensure](#) thorough cleaning and cap ends of lines.
- f. Inspect for and remove extraneous material as part of the assembly step, conduct a FO inspection and remove debris.
- g. Inspect production tooling (jigs, fixtures, handling equipment, or other production tools) to [assureensure](#) it is clean, undamaged and free of foreign material prior to installation and build-up of components or assemblies. Exercise this same care for scaffolding, work stands, ladders, special test equipment, or like equipment, which shall be placed on, in, or around critical hardware to accomplish specific tasks.
- h. Protect products by using FO barriers, foam pads, covers, etc. Always protect sensitive areas and potential FO entrapment areas.
- i. Provide for proper instruction, performance of and inspections necessary to remove any caps or seals used for FO and FOD prevention that must be removed during assembly/build-up of a system.

3.4.9 ~~3.2.9~~ Physical Entry Into FOD-Critical Areas

3.4.9.1 ~~3.2.9.1~~ When physical entry into a FOD-Critical Area is required, personnel shall remove all loose objects, badges, jewelry, etc. from clothing.

3.4.9.2 ~~3.2.9.2~~ Pocketless coveralls should be worn in FOD-Critical Areas to preclude FOs dropping from pockets.

3.4.9.3 ~~3.2.9.3~~ Personal items that are required in FOD-Critical Areas, such as eyewear, ear protection, etc. shall be accounted for upon exit of the FOD Critical Area by using FOD/Tool Log sheets.

~~3.2.10~~ Physical Entry Into FOD Control or Awareness Areas

3.4.10 ~~3.2.10.1~~ Refer [Refer](#) to Appendix B, Foreign Object Damage (FOD) Areas, for some controls used in [physical entry into](#) FOD Control or Awareness Areas.

CHAPTER 4: Design Considerations

4.1 The reduction of damage potential and elimination of FOD hazards shall begin with the design process.

4.2 Design considerations may include:

- a. Identify and eliminate FO entrapment areas.
- b. Identify and seal areas through which FOs can migrate.
- c. Use screens over exposed openings when appropriate: e.g., intakes, exhausts, etc.
- d. Install special access panels, ports, etc., for inspection and clean-out of FOs that could potentially cause damage.
- e. Use blind fasteners in critical areas that are not prone to leaving debris during installation.
- f. Use fasteners with self-retaining features to secure high usage access panels.
- g. Locate service points, ground points, and built-in test equipment in areas, which are least FOD-sensitive.
- h. Use compatible metals and seals to prevent accelerated deterioration and subsequent failure of seal materials.
- i. Use conformal coatings as a positive seal against entry of minute FO, including dust and water vapor.

CHAPTER 5: Guidelines for Wind Tunnels

5.1 Domestic Items

5.1.1 A domestic item is an actual part of the tunnel structure (e.g. piece of wind tunnel ceiling broken off due to facility deterioration, backing screen wire grid deterioration, panel arc sector, etc.).

5.1.2 Reporting of a Domestic Item found or Damage Caused by Domestic Items

5.1.2.1 When there is a domestic item found, but no damage has occurred, a ~~Langley Form (LF)~~ 360 is not required, however the LaRC Safety Manager shall be contacted and a Safety Concern shall be submitted online by completing an LF 164, "Report of LaRC Safety/Health Concern/Close Call" located at <https://safety.larc.nasa.gov/index.cfm?ContentID=4>.

5.1.2.2 When damage is caused by a domestic item, an LF 360 is not required; however, this event is considered a Mishap and shall be reported by dialing 4-SAFE (4-7233) from any Center telephone or (757) 864-7233 from a cell phone, and a Safety Concern shall be submitted online by completing an LF 164, located at <https://safety.larc.nasa.gov/index.cfm?ContentID=4>.

5.2 Reporting of a ~~Foreign Object (FO)~~ and ~~Foreign Object Damage (FOD)~~

5.2.1 When a FO (without damage) or FOD is discovered, the following procedures shall be followed:

- a. Complete an LF 360.
- b. Contact all of the following personnel:

~~(2)~~(1) ~~Safety and Mission Assurance Office (SMAO)~~SMAO Facility System Safety Engineer

~~(3)~~(2) FOD Program Manager

~~(4)~~(3) FOD Representative

~~(5)~~(4) Project Manager or Facility Safety

- c. Submit a Safety Concern online by completing an LF 164, located at <https://safety.larc.nasa.gov/index.cfm?ContentID=4>.
- d. When damage occurs, this event is considered a Mishap and shall be reported by dialing 4-SAFE (4-7233) from any Center telephone or (757) 864-7233 from a cell phone.

APPENDIX A: Definitions

A.1 Clean-As-You-Go – Defined by National Aerospace FOD Prevention, Inc. (NAFPI) as follows: “Clean the immediate area when work cannot continue. Clean the immediate area when debris has the potential to migrate to an out of sight or inaccessible area and give the appearance of poor workmanship. Clean the area prior to leaving it unattended, when work cannot continue, after work is completed or at the end of shift, whichever comes first. If you see something, drop something, see or hear something drop, pick it up.”

A.2 Consumables – For the purposes of this procedure, supplies provided to workers that are considered expendable; i.e., personal protective equipment, sealants, solvents, paint, brushes, applicators, sandpaper, rags, wipes, rivets, washers, fasteners, and other hardware.

A.3 Corrective Action Plan – Steps to be taken to prevent the root cause(s) of a FO and/or FOD incident from occurring again. The corrective action plan is not the direction necessary to remove the FO and restore the hardware.

A.4 Critical Foreign Object – FO debris that has a significant probability of causing system or component malfunction or deterioration if the item containing the FO debris is put into use.

A.5 Domestic Item – For purposes of this procedure, an item that is an actual part of the tunnel structure (e.g. piece of wind tunnel ceiling broken off due to facility deterioration, backing screen wire grid deterioration, panel arc sector, etc.).

A.56 Flight Hardware – All LaRC projects which produce, launch and/or operate flight hardware and/or software. The scope or coverage includes all exploration projects, atmospheric science instruments, satellites and missions, International Space Station payloads and experiments, and planetary science payloads missions, ~~also be on~~ risk reduction flights; flight experiments or technology demonstrations; flights of opportunity that are sub-orbital; involve sounding rockets; un-crewed aerospace vehicles; drop models; and major Unmanned Aerial Vehicle (UAV) operations as determined by management.

~~**A.6 Foreign Object Damage (7 FOD)** – Any damage attributed to a FO that can be expressed in physical or economic terms, which may or may not degrade the product's safety and/or performance characteristics.~~

~~**A.7 Foreign Object (8 FO)** – A substance, debris or article alien to a hardware or system which could potentially cause damage.~~

~~**A.8 Foreign Object Damage (FOD)9 FOD Awareness Area** – Any area designated as a low-risk area where quality-sensitive products or hardware are in place and~~

exposure to FOs would potentially cause a system or product malfunction or failure. Organizational Culture is focused on safety, reliability, and functionality by protecting all personnel, products and services from FO debris and damage.

A.9 Foreign Object Damage (10 FOD) Control Area – Any area identified as a medium-risk area where quality-sensitive products or hardware are in place and exposure to FOs would potentially cause system or product damage, malfunction or failure. Stringent accountability measures shall be applied to control the risk of FOD in the area.

A.10 Foreign Object Damage (11 FOD) Critical Area – Any area identified as a high-risk area where quality-sensitive products or hardware are in place and exposure to FOs would potentially cause system or product damage, malfunction or failure. Strict accountability measures shall be applied to control the risk of FOD in the area.

A.11 Foreign Object Damage (12 FOD) Sensitive Area – Any area designated as either a FOD Awareness Area, a FOD Control Area, or a FOD Critical Area.

A.12 Foreign Object Damage (A.13 FOD) Sensitive Work – Work that is being conducted in a FOD-sensitive area.

A.13 Foreign Object (A.14 FO) and Foreign Object Damage (FOD) Incident – An instance where a FO or FOD is found.

A.1415 Housekeeping – Basic element of controlling a safe and effective work environment. Proper cleaning and organizing techniques are followed to ensure the prevention and elimination of FOs. Maintenance, manufacturing, testing and all other operational areas shall remain clean and organized with the ultimate goal to prevent debris from migrating into critical and complex hardware and facilities. The clean-as-you-go work ethic is one of the most effective provisions for production, service, and preservation of products.

A.1516 Non-FOD-Sensitive – An area where the risk associated with a FO is negligible and no FOD control measures are needed.

A.1617 Shadowbox – A tool box with specific, marked locations for each tool so that a missing tool will be readily noticeable.

A.1718 Tether – A lanyard of sufficient strength (wire, rope, cable, etc.) attached to the tool/equipment and to the user or fixed secure object. The tether should be minimum length to preclude damage from tethered tool “free swing”.

A.1819 Tote Tray – A device for storing/carrying/transporting tools or equipment in a secure manner to prevent inadvertent dropping: i.e., a tool holder, an apron with pocket rings to which tools can be secured. Tote trays with lids will have the lid secured to the tote tray body.

APPENDIX B: Foreign Object Damage (FOD) FOD Areas

Attribute	Area Level			
	FOD CRITICAL	FOD CONTROL	FOD AWARENESS	Non-FOD-Sensitive
Training	FOD General Awareness. FOD Specific Area.	FOD General Awareness. FOD Specific Area.	FOD General Awareness.	FOD General Awareness.
Area Access (signage)	"FOD CRITICAL" signs posted. Controlled entry and exit.	"FOD CONTROL" signs posted. Limited area access.	"FOD AWARENESS" signs posted.	None
Housekeeping	Practice superior housekeeping standards. Practice "Clean-As-You-Go." Perform scheduled walk downs. No smoking, food or drink allowed.	Practice superior housekeeping standards. Practice "Clean-As-You-Go." Perform scheduled walk downs. . Smoking, food or drink in authorized areas only.	Practice good housekeeping standards. Practice "Clean-As-You-Go." Perform scheduled walk downs. Smoking, food or drink in authorized areas only.	Customary Janitorial Practices
Tool Accountability	Strict tool (temporary and personal) accountability enforced. Accountability shall include any items taken into the FOD area. No FOs allowed in tool boxes.	Stringent tool accountability enforced including temporary and personal tools.	Standard tool accountability recommended.	None
Consumables	Storage separate from point of use, carried in sealable containers, strict accountability of quantity and type during use. Unused or spent consumables returned to storage or dispositioned after use.	Storage separate from point of use, carried in sealable containers. Use only items needed to accomplish task. Unused or spent consumables returned to storage or dispositioned after use.	Users take only items needed to accomplish task. Unused or spent consumables returned to storage or dispositioned after use.	No requirement
Material Handling, Packaging, Shipping (see chapter 3.2.3)	Clean containers prior to use, install FO barriers during movement and storage, and use packaging that does not produce FOs.	Clean containers prior to use, install FO barriers during movement and storage, and use packaging that does not produce FOs.	Clean containers prior to use, install FO barriers during movement and storage, and use packaging that does not produce FOs.	Customary practice
Attire and Personal Items	No personal items (i.e., jewelry, keys wallets permitted). No phones or pagers (unless safety / communication requirement). Ensure eyewear, ear protection and badges are secure. Personal items should be accounted for upon exit of the FOD area, by using FOD/Tool Log sheets.	Secure jewelry and badges. Authorized use of phones and pagers. Personal items should be accounted for upon exit of the FOD area, by using FOD/Tool Log sheets	Secure jewelry and badges. Authorized use of phones and pagers.	No restrictions.