A Note from the Publisher


Dr. Michael Lesiecki served as co-author of this report. Michael Lesiecki, PhD, CRA, is the principal investigator for a large grant from the National Science Foundation’s Advanced Technological Education program. He has 27 peer-reviewed journal publications and a patent. He received his PhD in Physical Chemistry from Oregon State University. He was a Research Professor at the University of Utah and an Associate Professor at the University of Puerto Rico. At Exxon Research and Engineering, Dr. Lesiecki worked as a Senior Scientist and was the director of the Bioscience Division at Candela Laser Corporation. He authored successful SBIR proposals while at Candela, including six Phase I and five Phase II grants to the National Institutes of Health. Dr. Lesiecki left Candela to open Scion Scientific, with a Phase-I SBIR grant from the National Eye Institute.

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We are always on the lookout for interesting topics, researcher needs, and ways we can be of service to you. If you have a success story you would like to share with your colleagues, please do not hesitate to contact me. I would be delighted to hear from you, and I look forward to serving you and your organization with the best advice and information available in the future.

Best Regards,

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Introduction

Data management plans have become an increasingly crucial part of your NIH and NSF grant proposals, sparking tension headaches among researchers everywhere. Further, the NSF recently ratcheted up its requirements with a new set of mandates for data management plans.

According to Dr. Michael Lesiecki, Executive Director of the Maricopa Advanced Technology Education Center, there are several key factors in composing a proper data management plan:

• Understand what counts as “data;”
• Know the NSF’s and NIH’s requirements and expectations for data management plans;
• Follow the policies set out for accessing and sharing data;
• Learn how to determine the data management requirements specific to the directorate, office, division, program or institute; and
• Understand how to fund the data management plan, and find model plans and processes.

The increasing emphasis that funding agencies are placing on data management -- and the multitude of evolutions and changes to the regulations -- is due to the constantly changing technology, says Dr. Lesiecki, who has served as both a PI and a grant reviewer. With the emergence of cloud computing, digital repositories and even new biological storage solutions, the NIH and NSF are frequently updating their mandates to keep up.

Although data management plans may seem daunting and even confusing, you can follow a few simple directives to make your plan a winning one. Keep in mind that your data management plan won’t just help you to comply with agencies’ expectations, but instead it will also help you to disseminate your research widely.
Section I:
Understand What Counts As ‘Data’

First and foremost, to compose a data management plan you must understand what funding agencies define as “data.” Data is “the recorded factual materials commonly accepted in the research community to validate research findings,” Dr. Lesiecki says.

In a basic sense, the definition refers to the type of data that’s suitable for a peer-reviewed journal publication. But data also refers to both “analyzed data” and “metadata” that define how the data were generated. Data are also those published in theses, dissertations, reviewed journals, books, electronic publication formats and even supplemental data attachments for manuscripts.

Beyond the standard publications, you should also include data from:

• *Observations* -- These could be images, atmospheric profiles and other types of observation-related data. For example, a series of images -- perhaps PET scans -- that you archived from your analysis of brain functionality.
• *Experiments* -- These can include data that streams from conducting an experiment. For instance, data streaming from a nuclear magnetic resonance experiment would fall into this category.
• *Simulations* -- These might be Computational Fluid Dynamics (CFD), T-allele polymorphism and other types of simulations, which would count as data.
• *Compilations* -- These are very common in research fields and include compilations of data, or data sets.
• *Models* -- Data generated by models also count.

What’s Not Considered Data

Understanding what agencies don’t regard as data is just as important as what is data. When you’re developing a data management plan, you would not include:

• Preliminary analysis or results;
• Drafts of papers (prior to publication);
• Plans for future research; and
• Communications with your peers about your findings.
Section II:

Great Expectations: What the NIH & NSF Want Your Plan to Look Like

You likely have your own expectations of what you’d like to do with your data, but you must have a solid, in-depth understanding of what the agencies want your data management plan to look like. The NIH and the NSF each have their own particular expectations when it comes to data management plans.

What the NIH Wants

When applying to the NIH, your plan should be titled “Data Sharing Plan,” instead of Data Management Plan. You’ll place this section of the proposal immediately after your research plan section.

According to the NIH’s directives, “The NIH expects and supports the timely release and sharing of final research data from NIH-supported studies for use by other researchers... Investigators submitting an NIH application seeking $500,000 or more in direct costs in any single year are expected to include a plan for data sharing or state why data sharing is not possible.”

In this one short snippet, the NIH draws out several key elements:

• “Final research data” refers to the real data listed earlier here, and not preliminary data. This is also not summaries of data -- tables, statistics, etc. -- but the data on which those summaries are based. The NIH is expecting a computerized data set here.

• $500,000 in direct costs per year means that you’re looking at research projects funded in the $1 million-per-year realm.

• That last statement about explaining why your project won’t actually generate data and so wouldn’t fall under the Data Sharing Plan rules is an important point to assess as well.

Another note on “final research data,” as the NIH defines it, is that this data also applies to clinical research,
surveys and other types of data. Researchers applying for NIH grants may work with human and pre-clinical studies, which bear their own specific constraints.

If you’re conducting human studies, you should show special attention in your data management plan to privacy and HIPAA restrictions. You’ll need to redact your data to strip all identifying information and create a policy to minimize the risk of unauthorized disclosures. Think about and use your proposed clinical trial’s study design -- particularly the informed consent and how these factors will shape the resulting dataset’s structure.

The NIH also specifies how it wants you to share data. The PI can share the data personally, but these days you’re likely using a data “archive,” a data “enclave” or both. A data enclave is a secure environment for storing, analyzing and selectively sharing restricted data sources.

Aside from HIPAA-related privacy issues involving human studies, you may also want to have a more restricted data sharing plan if the research data is proprietary -- particularly if you’re applying for a Small Business Innovation Research (SBIR) grant. Or perhaps your study is co-funded by industry collaborators and the proprietary data will need to be confidential for a set timeframe according to your sponsored research agreement. You need to spell out these factors in your data management plan.

**What the NSF Wants -- Similar but Different**

The NSF’s Data Management Plan is a two-page attachment to your proposal and isn’t included in the original total page count, but instead is included among your supplementary documents. You also have to state in your proposal whether you have a data plan or are seeking an exemption.

The NSF’s data requirements are in essence the same as the NIH’s rules, but with a few key differences.

The NSF says: “Investigators are expected to share with other researchers, at no more than incremental cost and within a reasonable time, the primary data, samples, physical collections and other supporting materials created or gathered in the course of work under NSF grants. Grantees are expected to encourage and facilitate such sharing.”
The notable differences in the NSF's rules include:

- You can list "reasonable costs" associated with your data management plan;
- You must specify the reasonable timeframe for you to produce the real data (not the preliminary data); and
- You must follow the confidentiality rules and any Human Studies regulations.

You must also adhere to any additional or unique requirements that come from the NSF directorates. For example, the NSF Chemistry directorate states that your data management plan would need to include additional specific types of data like numerical data on chemical systems. The directorates are often more specific on its data management mandates.

**Go to the GPG for Your Data Plan Checklist**

If you want a clear, concise list of all the elements you need to include in your data management plan, look no further than your handy grant proposal guide (GPG). The GPG sets out five main elements required in your plan:

1. **Data Types** -- Identify the types of data in your work, such as published writings, observations, experiments, simulations, compilations, models, etc.

2. **Applicable Data & Metadata Standards** -- Identify your standards for managing and saving data and metadata.

3. **Access & Sharing Policies** -- Include policies for accessing and sharing the data, focusing on how you will protect privacy, confidentiality and intellectual property, if necessary. What kind of security do you need to protect the data, and what kinds of restrictions might you need to place on the data?

4. **Re-Use, Distribution & Derivatization Policies** -- What will be your policy for how the data is reused? Will you require permission for each re-use, distribution and derivatization?

5. **Archiving Plans** -- Spell out your specific plan for archiving the data, including how, where and for how long you'll archive it.
**Remember NSF Annual & Final Reports**

You aren’t finished with data management after you complete your proposal. If you nab an NSF award, the Foundation wants to monitor your implementation of the data management plan. The NSF requires reporting on your data management plan annually, in your final report and in subsequent proposals under “Results of Prior NSF Support.”

The NSF requires annual project reports for all multi-year awards. In your annual reports, you must include information about the progress you’ve made in data management and sharing research products, such as:

- Citations of relevant publications;
- Conference proceedings; and
- Other types of data sharing and dissemination.

The NSF requires final project reports for all awards. In your final report, you must detail your data management plan implementation, as well as:

- Any changes you made from the original plan;
- The data you produced during the award period;
- The data that you’ll retain after the award expires;
- How you’ll disseminate the data;
- Verification that you’ll make the data available for sharing;
- The format (including community standards) that you’ll use to make the data and any metadata available to others; and
- The data’s archival location.
Section III:

Archive Your Data the Right Way

By looking at the GPG checklist, you can see that both the NIH and NSF want you to spell out in your plan exactly how you plan to save, archive or store your data. The agencies don’t require you to save data in any specific way -- you must decide what you need to save and for how long. And if you’re not sure about the best way to store your data, don’t be afraid to contact your program officer to talk it over.

You might store hard copies of data in a file cabinet, but most of these types of data are stored electronically these days. The vast majority of data is stored in the cloud or in a digital library repository.

If you have physical specimens or biological samples, you’ll need to state in your plan that you’ll store them in a freezer or other appropriate place and the location of that storage container or freezer.

Although the manner in which you save the data is largely up to your own discretion, there are “right” and “wrong” ways to archive data.

Choose from Many Different Digital Libraries

In this day in age, storing data primarily in a filing cabinet isn’t probably the most impressive data management plan for grant reviewers. Although filing cabinet storage as a secondary option might be helpful, if you believe that doing so will enable more people to access the data.

Digital libraries have been around for several years now, and they’re constantly improving and becoming increasingly user-friendly. There are a multitude of digital repositories and other solutions for archiving and distributing your data (see Appendix B for an expanded list).

For example, the National Science Digital Library (NSDL) is a user-friendly repository of data sets and collections. The NSDL is an online portal for information and research on education in the Science, Technology, Engineering and Math (STEM) arena. This portal is also NSF-funded, so if you’re applying for an NSF grant, using
NSDL for archiving your data is a smart move, Dr. Lesiecki says.

The Dataverse Network is another excellent option. Dataverse is an open-source digital library designed to manage, disseminate, cite and exchange virtual data collections, or “dataverses.” Dataverse is actually a software package that you can purchase to manage your digital repository of data.

Tip: Many institutions are now creating their own repositories and libraries. Colleges, universities and other research organizations have these digital libraries. If your own institution has one of these, start there when you’re developing a data management plan.

**Case Study: How to Create a Data Repository**

Dr. Lesiecki shares his own experience in creating a data repository for a data management plan. Dr. Lesiecki contacted the University of Wisconsin at Madison to inquire about its Internet Scout project. The university had developed an open-sourced platform called the Collection Workflow Integration System (CWIS), which he installed onto his own college’s server.

The University of Wisconsin at Madison designed CWIS specifically to help build collections of STEM resources and connect them to the NSF’s NSDL. Today, CWIS has a wide range of other uses as well.

The difficult part was understanding CWIS’s metadata tagging system, which the university based on the Dublin Core standards, with user-defined special vocabulary, Dr. Lesiecki notes.

Dr. Lesiecki then created the resource -- a large Excel file -- and gave it a unique URL on his college server in order to share it with Internet Scout. He described the resource in CWIS, added descriptive search terms, added metatags and “submitted” the information. Dr. Lesiecki had to think about how individuals would search for the information and come up with about 79 words as search terms to enable users to find the data.

By taking these steps and setting up his archived data in CWIS, Dr. Lesiecki enabled anybody visiting the college’s site or Internet Scout (or searching via Google) to search, access and even download the file and description. So essentially, using a single system, he was able to create the resource, archive the research and share the data.
So Dr. Lesiecki complied with the NIH’s standards, metatags and so on via CWIS; he composed a usage policy by providing open access to the resource through an easy login; and he utilized the dual server to ensure long-term archiving and data integrity. Further, he expanded his data dissemination through CWIS’s connection with the NSDL and the natural user search via Google.

**Heed the NSF Requirements Specific to Your Discipline**

Although many directorates adhere to the general GPG requirements when it comes to data management plans, some directorates and divisions have more specific mandates. Further, some offer pre-made forms that you can fill out and submit as your data management plan along with your proposal, such as the Directorate of Geosciences, Division of Atmospheric and Geospace Sciences -- [http://www.nsf.gov/geo/geo-data-policies/ags/ags_data_mgt_form.pdf](http://www.nsf.gov/geo/geo-data-policies/ags/ags_data_mgt_form.pdf).

One section in particular has a variety of more stringent data management requirements specific to its division -- NSF’s Directorate of Geosciences, Division of Ocean Sciences (OCE). According to the NSF, the additional requirements and conditions for OCE awards include:

1. You must submit (at no more than incremental cost and within a reasonable timeframe), no later than two years after the data are collected, the primary data, samples, physical collections and other supporting materials created or gathered in the course of work under the NSF/OCE grants to the appropriate Data Center. If you submit your data to an alternate database, you must still submit the data to a National Data Center -- unless the alternate database is among the NSF-funded data management groups that deposits data into the National Data Centers. Some OCE core programs have specific data management groups to which you must submit your data; these include Chemical Oceanography, Biological Oceanography, and Marine Geology and Geophysics. National Data Centers include:

   - National Oceanographic Data Center (NODC) - [http://www.nodc.noaa.gov](http://www.nodc.noaa.gov)
   - National Climatic Data Center (NCDC) - [http://lwf.ncdc.noaa.gov/oa/ncdc.html](http://lwf.ncdc.noaa.gov/oa/ncdc.html)
   - National Geophysical Data Center (NGDC) - [http://www.ngdc.noaa.gov/ngdc.html](http://www.ngdc.noaa.gov/ngdc.html)
   - National Snow & Ice Data Center (NSIDC) - [http://nsidc.org/data/](http://nsidc.org/data/)
   - National Carbon Dioxide Information Analysis Center (CDIAC) - [http://cdiac.esd.ornl.gov/home.html](http://cdiac.esd.ornl.gov/home.html)
2. If no data or sample repository exists for the collected data or samples, you must prepare metadata and make it publicly available over the Internet, and you must employ alternative strategies for complying with the general philosophy of sharing research products and data. Where appropriate, you should curate samples in a manner that preserves their quality and integrity. Consult your NSF Program Officer when in doubt about what to do.

3. If you collect standard underway data at sea aboard NSF-supported oceanographic research vessels, you must submit all such data sets to the appropriate long-term archive through the Rolling Deck to Repository (R2R) program. For other at-sea, special ops or research-specific data sets that you collect on a cruise -- such as water samples, ROV sampling, dredge hauls, etc. -- you are responsible for collecting and making public the metadata associated with sample collection and the data or results from the research. See http://www.rvdata.us/about/underway for more information.

4. The PI, his institution and ship-operating institutions are responsible for meeting all foreign government-imposed legal requirements for data and research results submissions, as part of that government’s conditions for granting research clearances. You must determine your legal obligations with the NSF’s and U.S. State Department's assistance if necessary.

5. Focused community-driven science programs supported by OCE core programs sometimes have more stringent or alternate data submission procedures:


- Marine Geology and Geophysics Data Management Office, also called Integrated Earth Data Applications (IEDA) -- Serves projects funded by the Marine Geology and Geophysics Program, programs in the Earth Sciences Division, and some parts of the Office of Polar Programs. See http://www.iedadata.org.

- Ocean Drilling Program (ODP) -- Serves drilling-related research programs, including Expedition Objective Research, and downhole geophysical and geochemical experiments. See http://ssdb.iodp.org.

- U.S. CLIVAR -- Serves projects relating to Climate Variability and Predictability. See http://www.usclivar.org
6. If you use genomic techniques, you should articulate a strategy for providing timely community access to the data you collect and for establishing links between genomic and environmental data. You should submit sequence data to a publicly accessible data repository like the National Center for Biotechnology Information. Review guidance on pre-publication access to sequence data at http://www.genome.gov/page.cfm?pageID=10506537.

The following are the OCE program-specific instructions on the infrastructure to support sample deposition and archiving:

**A. Marine Geological Samples:** You must archive and curate sediment, core and dredge samples, and make them available to other investigators as soon as possible -- but no later than two years after you collect the samples. You should archive samples at NSF-approved repositories; if you choose to archive at another institution (or home institution), you must meet the following conditions:

1. You should curate samples in an institutional facility that has a written and publicly-discoverable sample distribution policy;

2. You must make samples available to any U.S. investigator upon his/her request;

3. Within 60 days post-cruise, you must submit metadata on samples and where you’ve archived them to the appropriate National Data Center, as well as to the IEDA and the Marine Geology and Geophysics Data Management Group;

4. If you transfer samples to a new location for permanent archiving, you must update the metadata at the National Data Center or IEDA and the Marine Geology and Geophysics Data Management Group.

NSF-approved repositories for marine geological samples include:

- Lamont-Doherty Earth Observatory -- [http://www.ldeo.columbia.edu/core-repository](http://www.ldeo.columbia.edu/core-repository)
- Oregon State University -- [http://corelab-www.oce.orst.edu](http://corelab-www.oce.orst.edu)
- Scripps Institution of Oceanography -- [http://gc.ucsd.edu](http://gc.ucsd.edu)
- University of Rhode Island -- [http://www.gso.uri.edu/MGSLsite/mgsl Homepage.htm](http://www.gso.uri.edu/MGSLsite/mgsl_homepage.htm)
- Woods Hole Oceanographic Institution -- [http://www.whoi.edu/corelab](http://www.whoi.edu/corelab)
• The Bremen Core Repository (BCR) -- [http://www.marum.de/en/IODP_Core_Repository.html](http://www.marum.de/en/IODP_Core_Repository.html)
• The Gulf Coast Repository (GCR) -- [http://iodp.tamu.edu/curation/gcr](http://iodp.tamu.edu/curation/gcr)
• The Rutgers/New Jersey Geological Survey
• The Provasoli-Guillard National Center for Culture of Marine Phytoplankton (CCMP) -- [https://ccmp.bigelow.org](https://ccmp.bigelow.org)

**B. Biological Samples:** Although scientists have traditionally curated biological materials in academic, private and community facilities, not all materials should go to these facilities. You should, however, share valuable sample material by providing metadata, to provide samples early in the research program’s development. ■
Conclusion

Instead of looking at your data management plan as a necessary evil to nab that NSF or NIH grant funding, take a different viewpoint. Developing your data management plan should get you thinking about all the various ways you can archive and disseminate your research to the world.

When you’re designing your plan, ask yourself key questions to get yourself on the right track.

Archiving:

- How long should you plan to keep the data? (Do you want to keep the data forever, or are there “aging” factors associated with the data?)
- Have you selected a depository archive or digital library, or will you use your own institution’s server?
- How do you need to prepare the data for long-term storage?
- Are there costs associated with data preservation or funding needed for back-up processes?
- What will be the long-term location for preserving the data and backing it up?
- What will happen to the data if you switch institutions? (How will you transfer the documentation and curation responsibilities from one institution to another?)

Access

- What, if any, are the privacy concerns and ethical issues surrounding the data?
- Are there any confidentiality concerns?
- Is the data’s release embargoed for intellectual property considerations?
- Do you want to limit access to the data or allow access by only certain people?
- Do you have any reason to license the data content? (Do you want to release the data under Creative Commons -- [http://creativecommons.org/choose/zero](http://creativecommons.org/choose/zero)?)

Also, remember to include the five essential elements to a thorough data management plan:

1. Types of data;
2. Standards that you’ll apply for format, metadata content, etc.;
3. Provisions for archiving and preservation;
4. Access policies and provisions for data re-use; and
5. Plans for transition or termination of the data collection in the future.
Appendix A

Data Management Plan FAQs

Q: *If my proposed research does not generate data, do I need a data management plan?*

A: Yes, you need a plan, insofar that you need a statement saying why do not need a data management plan. The reviewers will look for this statement explaining exactly why you don’t need a plan.

Q: *Do the NSF and NIH have any policies on the types of samples I should have or save?*

A: The agencies tend to give you more general policies, but the individual directorate or institute is usually more specific on this. Contact your program officer to get the right guidance on what types of samples you should include in your data management plan.

Q: *How long should I plan on maintaining my data collection?*

A: The answer depends on your particular data and where you’re working. In most cases, you don’t need to maintain the data collection forever, even if the data is more evergreen or pertinent for a long time. In some cases, your data’s value may age-out due to some kind of national cycle or other factors, making the data lose all significant value in one, two or five years, for example.

Q: *In the regulations, what do the agencies mean by “unique data” and “timely” accessibility of data?*

A: Although the agencies use the term “unique data” throughout the regulations, what this really means is data that is very costly or difficult to produce. If other researchers would find it difficult to reproduce your data set, the agencies consider it “unique.”

“Timely” is a pretty vague term in the regulations for when you should make the data accessible. When asked, a program officer told Dr. Lesiecki that the term “timely” actually refers to about the timeframe between your data submission and the release of a journal publication. So you should use the same timeframe for making data accessible in a repository or digital library as you would for publishing it in a journal.
Q: If I’m not able to find one of these collective databases to provide access, what can I do?

A: If you’re having difficulty finding a collective database, you can try some helpful resources like MIT’s list of data repositories (http://libraries.mit.edu/guides/subjects/data-management/publishing.html#icpsr), or try the NSDL for more options. Contact the folks at MIT or at the NDSL, or even contact your program officer for ideas as well. If all else fails, you study online resources for setting up your own repository (see Appendix B).
Appendix B

Essential Resources, Examples & Other Links

There are a multitude of resources online that can provide information on and even samples of data management plans. Below are just a few.

Information on Data Management Plans

From funding agencies:

• NIH

http://grants.nih.gov/grants/policy/data_sharing/


• NSF


From universities:

• University of Connecticut

http://www.lib.uconn.edu/scholarlycommunication/data.html

• University of Idaho

http://www.uidaho.edu/research/fundingagencies/proposal/nsfdatamanagementplan

• Massachusetts Institute of Technology


• University of California

http://www.cdlib.org/services/uc3/datamanagement/funding.html
Resources for Sharing, Distributing & Archiving

- National Science Digital Library (NSDL)
  
  [http://nsdl.org](http://nsdl.org)

- National Digital Stewardship Alliance (NDSA)
  
  [http://www.digitalpreservation.gov/ndsa/members.html](http://www.digitalpreservation.gov/ndsa/members.html)

- The Dataverse Network
  
  [http://thedata.org](http://thedata.org)

- University of Wisconsin, Madison - Internet Scout project
  
  [http://scout.wisc.edu/Projects/CWIS](http://scout.wisc.edu/Projects/CWIS)

- MIT Data Repositories
  
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Section 1: Preparation: What Every PI Should Know Before You Start Applying
Section 2: Successfully Use Your Biosketch and Abstract to Define Your Project & Your Qualifications
Section 3: Prove Your Environment Supports Your Research
Section 4: Research Plan: Make the Most of Your Significance, Innovation, Approach & Overall Impact
Section 5: Special Considerations for Research Involving Human, Animals, or Select Agents
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