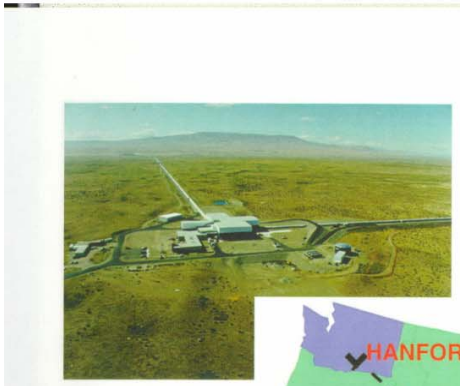
Hanford Site Information For Cut-and-Cover Solution

Fred Asiri-SLAC

In the beginning, the project consisted of building one facility near Caltech and the other one near MIT.
At the end, they were built at diagonally opposing locations.



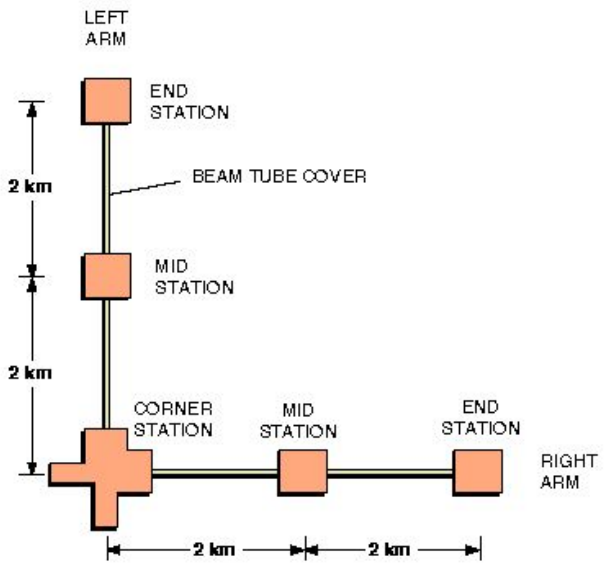


Fig. 1: Schematic layout of LIGO Site at Hanford, WA
(Installation at Livingston, LA has no mid-stations)

- 1987 Organized as a project
- 1988* Proposal (Site was baselined at the Edward Air force base area)
- 1989 Proposal was submitted to NSF
- 1990 NSF approved LIGO Proposal
- 1990 Site selection process started
- 1992 NSF announced the two LIGO Sites
- 1994 Site investigation & development completed
- 1996 Design completed
- 1999 Construction completed
- 2000 Detector installed
- 2001* Interferometers commissioned

Locations of 19 Proposed LIGO Sites

Site selection process

- Placed a site solicitation announcement in Commerce Business Daily (90 day response time)
- A committee was appointed to evaluate all proposed sites for technical suitability according to the Site Selection Criteria
- Prepared a document analysis of each site 's performance relative to Site Selection Criteria
- Submitted a written analysis and recommendations for a set of site pairs to NSF for approval
- Arranged for final transfer of the selected site

Site Evaluation process

- Collected information
  - ✓ From proposals
  - ✓ Site visits
  - ✓ Through letters
- Produced accurate assessments of :
  - ✓ Suitability
  - ✓ Risks
  - ✓ Costs
- Compared collected information with
  - ✓ Site Selection Criteria
  - ✓ Baseline Site
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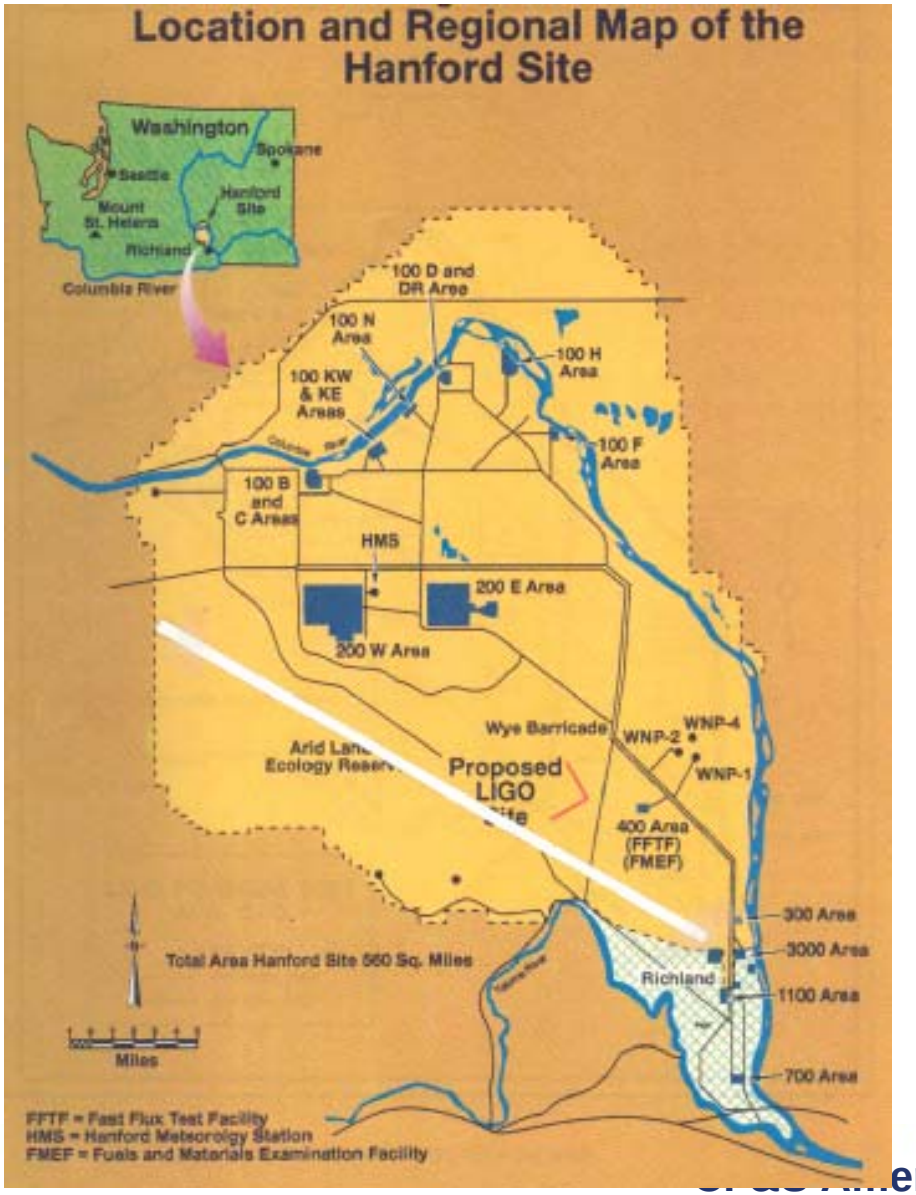


General Attributes

- The Hanford Site, area 560 Sq. Miles, is owned by the U.S. Government and administered by the DOE.
- The proposed site is remote from urban development and is not subject to encroachment.
- While remote, the Hanford Site has an excellent infrastructure.
- The area is served by an abundance of transportation modes.
- The Columbia River traverses much of the site with average flow of ~120,000 cfs.
- 1100-MW Washington Nuclear Plant No. 2 (WNP-2) is located on the site.
- The Pacific Northwest Laboratory is located adjacent to the site.

Aerial View of the LIGO Hanford Site

- Semi-arid desert
  - ✓ 7 inches of annual rain
  - ✓ 10 inches of annual snow
  - ✓ Surface varies +/- 20 ft
  - ✓ Sandy soil to ~500ft depth
  - ✓ Water table at ~400 ft depth
  - ✓ Well drained
  - ✓ No natural drainage crosses the site
  - ✓ No surface water problem
  - ✓ No hydrology issues
- Best geologically characterized sites in U.S.

Excerpts from Ambient Ground Vibration Report for the LIGO Hanford Site

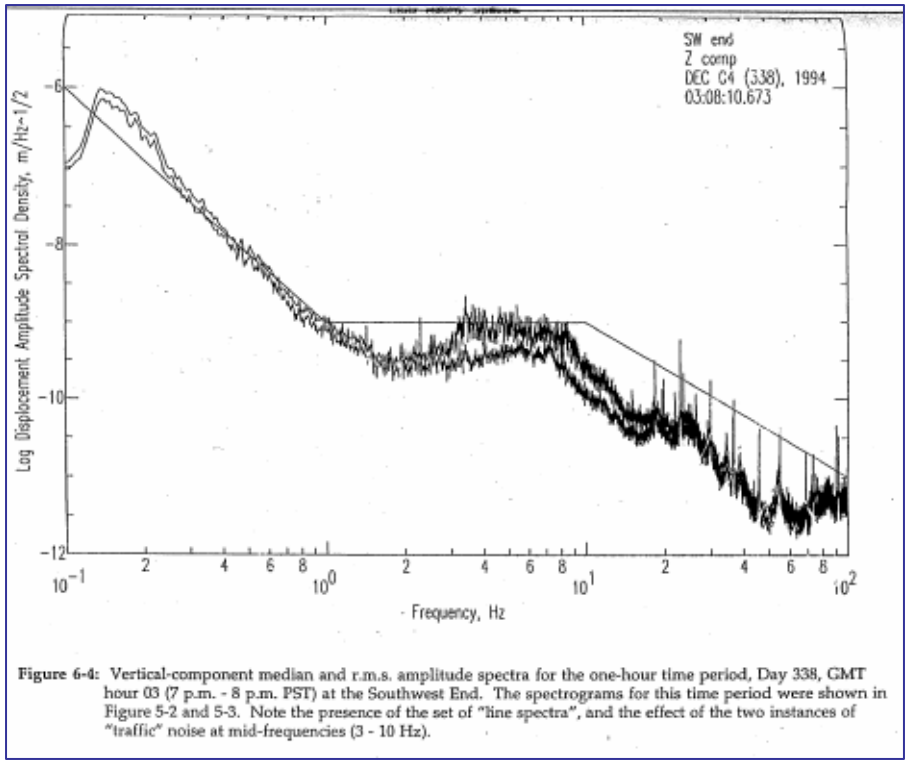


Figure 6-4: Vertical-component median and r.m.s. amplitude spectra for the one-hour time period, Day 338, GMT hour 03 (7 p.m. - 8 p.m. PST) at the Southwest End. The spectrograms for this time period were shown in Figure 5-2 and 5-3. Note the presence of the set of "line spectra", and the effect of the two instances of "traffic" noise at mid-frequencies (3 - 10 Hz).

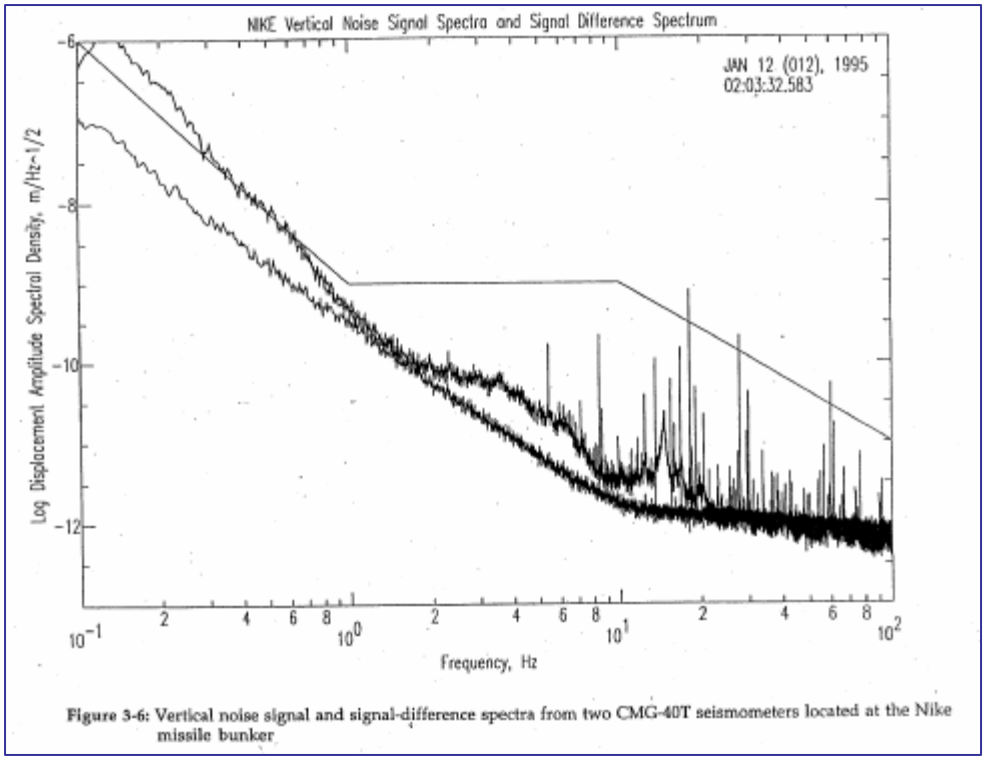


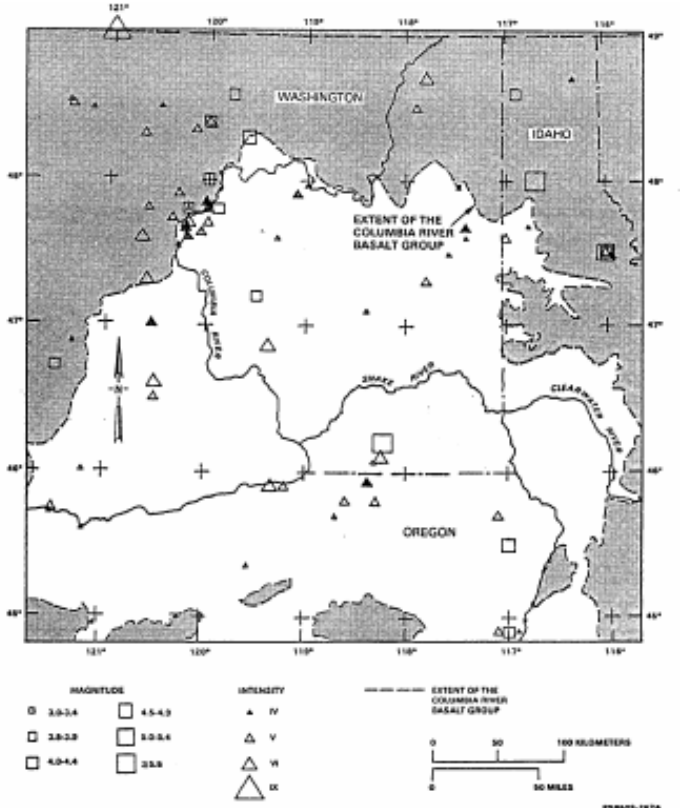
Figure 3-6: Vertical noise signal and signal-difference spectra from two CMG-40T seismometers located at the Nike missile bunker

Ambient Ground Vibration Measurements at the LIGO Southwest End Station on the Surface

Ambient Ground Vibration Measurements location 7.8 km southwest of SW LIGO End Station at the depth of ~ 8 M

Site is remote from urban area and is very quiet, especially at depth

Excerpts from the LIGO Geotechnical Reports



Seismic activity between 1850 to 1969

Figure 9. Historical seismicity of the Columbia Plateau and surrounding areas. All reported earthquakes between 1850 and 1969 with a Modified Mercalli intensity of IV or greater, or with a magnitude of 3 or greater.

The Hanford Site not only has a low seismic activity, but also has a very good subsurface geology for cut-and cover construction

Typical Soil Type	Natural Dry Density (pcf)	% Moisture	Compressional Wave Velocity	Shear Wave Velocity (fps)	Dynamic Shear Modulus (ksf)	Dynamic Poisson's Ratio
SP/SM	100	3	1660	735	1750	0.37
SP	105	3	4700	1200	4830	0.46
SP	125	3	3330	1700	11,700	0.32
GP	125	3	4150	1750	12,400	0.39
GP	125	7	6500	1850	14,800	0.46
GP	125	7	8800	2500	29,100	0.46
ML	100	25	6100	2000	12,400	0.44
ML/CL	125	25	8300	2800	30,400	0.43
GP	140	7	10,200	4200	78,700	0.40
Basalt			16,000	9000	400,000	0.27

Depth (feet): 0, 10, 20, 30, 40, 60, 80, 100, 120, 140, 160, 180, 200, 300, 400, 500, 600, 700

Elevation (feet): 530, 520, 510, 500, 490, 470, 450, 430, 410, 390, 370, 350, 330, 230, 130, 30, -70, -170

SP; Poorly-Graded Sands, Gravely Sands, Little or no Fines

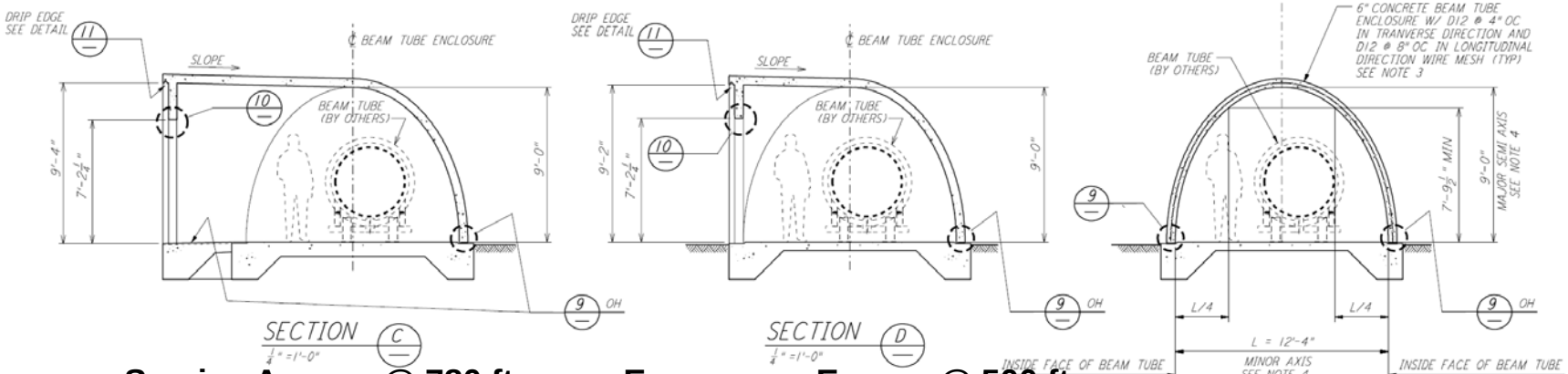
Soil parameters below Elevation 466 estimated using data from previous investigations.

SEISMIC DESIGN DATA
TYPICAL SOIL PROFILE

Job No. 00177-004-016
DAMES & MOORE
LIGO Project
Hanford, Washington
PLATE 7

Rough grading total cost in 95$:

- Actual cost $1,940K
- Excavation & Compaction ~$3.5 per cubic yard



Service Access @ 780 ft **Emergency Egress @ 500 ft**

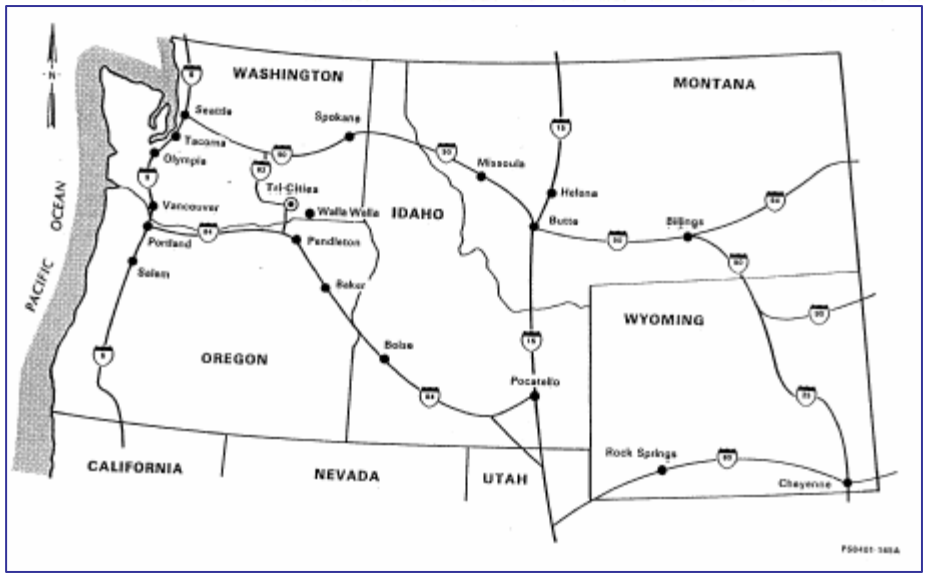
Beam Tube Enclosure total cost in 96$:

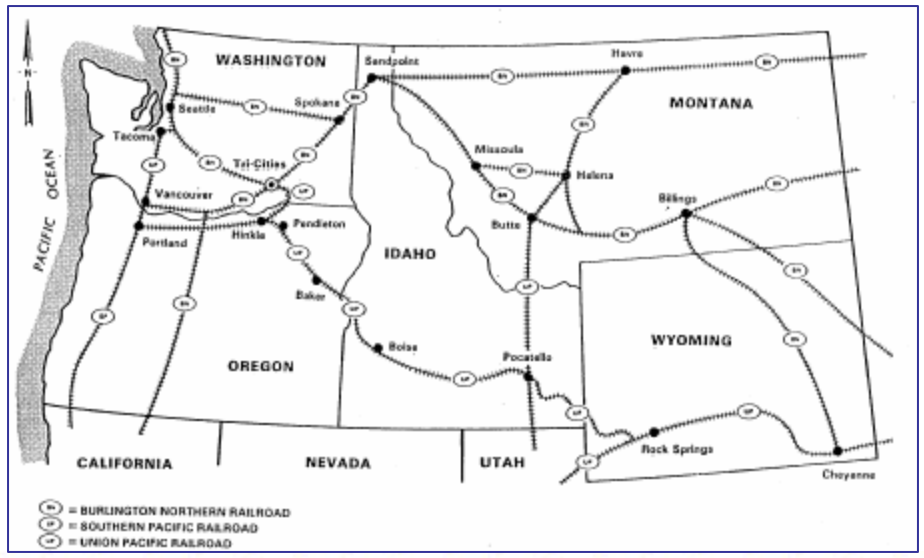
- Actual cost $8,971K
- ~ $28 per Sq. ft

Installation of Service access
Installation rate Ave. 260 ft/day

Slipform paver used for placement

- **8” thick concrete slab**
- **Class A finish**
- **Placement rate ~0.5 Km/ day**





- Bonneville Power with regional capacity of >43,000 MW, is extremely stable and cheap @ 3.5 cents per KW-hr.
- Area has abundance of water resources, the Columbia River with ~120,000 cfs.
- Hanford has an extensive infrastructure for supporting ~14,000 employees;
  - ✓ Hanford-private roads and state highway
  - ✓ A barge dock (1000 tons load capacity)
  - ✓ A government-owned railroad
  - ✓ The Tri-Cities Airport is 20 miles from the Site
  - ✓ Fire protection, medical, and business services
  - ✓ Data communication Center
  - ✓ Laboratory Support
  - ✓ Large skilled technical work force

Attributes of the U.S. Government Owned Land

- The land anticipated for is part of a government reservation; therefore, there is no need for a land transfer action.
  - ✓ Saves risky, time consuming and costly land acquisition process
  - ✓ All is required is a " Land Use Permit".
    - It took an order of magnitude less in time and money for the LIGO Hanford site than it took for the LIGO Livingston site
- DOE has extensive environmental data relative to the Hanford Site; therefore, preparation of an " Environmental Assessment" will satisfy the National Environmental Policy Act (NEPA) requirements.
  - ✓ Saves years of mitigation, litigation, risk and cost of preparing Environmental Impact Study
  - ✓ All that's required is a "Finding Of No Significant Impact" (FONSI).
    - It took an order of magnitude less in time and money for the LIGO Hanford site than it took for the LIGO Livingston site

In Value Management: ***Value = Worth/Cost***

- Saves at least one year in schedule and lots of money to obtain same level of geotechnical and seismic data for the other sites that are available for the Hanford Site.
- Saves years of mitigation and litigation as well as lots of money and headache in land acquisition and Environmental Impact studies.
- Save in civil construction cost by ease of construction, availability of material of construction, use of existing and extensive DOE infrastructure.
- Reliable, abundance and cheap sources of electric power and water will save in operation cost.

What is the *Worth* of not having the project at or near the FNAL ?

Optimum value is achieved when all criteria are met at the lowest overall cost. Value is a dimensionless expression.