“More than, Less than…”: Searching for Range of Numbers, with Numeric Indexing in Inspec

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Outline

- The Challenge: Search for range of values (weight, size, voltage, etc) -- “less than X, more than Y”
- Solution: Using “Numerical Index” search in Inspec

- Standardize numbers in Exponential (scientific) format
- Create search in Inspec, for:
  - Records where values (weight, etc) overlap with your searched range; or
  - Records where values (weight, etc) fall completely within searched range
- Sample searches
  - Size/Length (in Meters)
  - Frequency (in Hertz)
  - (Live Demo) Power (in Watts)

Search for Single Value

It is quite easy to search for a single, specific value such as:

- 40 mm
- 10 kilograms
- 1.5 kHz
- 3 Megawatts
- 18 degrees Kelvin

Search for Range

The challenge arises when you want to search for a range of values, such as:

- “40 mm to 100 mm”
- “more than 10 kilograms”
- “more than 3 megawatts but less than 50 megawatts”
- “less than 18 degrees Kelvin”

If you want articles re: “**Defibrillators with voltage greater than 50 volts**,” you could try a search like this:

Defibrillat* N/10 ("50 v" or "50 volts" or "greater than 50 v" or "greater than 50 volts" or "more than 50 v" or "more than 50 volts" or "over 50 v" or "over 50 volts")

…but this would probably NOT retrieve records that talk about defibrillators used with **60** volts, or **100** volts…or “**50-75** volts”. What is the solution?

Numeric Index searching, in the Inspec database!

In this case,

Defibrillat* N/10 ("50 v" or "50 volts" or "greater than 50 v" or "greater than 50 volts" or "more than 50 v" or "more than 50 volts" or "over 50 v" or "over 50 volts")

…gets **22** hits in Inspec. But, we can get **55** hits with Numeric Indexing:

Defibrillat* and nivo(>5E1)

So, let's back up, and look at Inspec…

Inspec: Overview

Content

Key resource for global, quality and comprehensive science and engineering information spanning 110 years for:

- **Physics**
- **Electrical and electronic engineering**
- **Computing and control engineering**
- **Information technology**
- **Production, manufacturing & mechanical engineering**

Numbers correct March 2015

Plus many interdisciplinary subjects such as nanotechnology, oceanography, environmental science…

The Institution of Engineering and Technology

Essential Engineering Intelligence ®

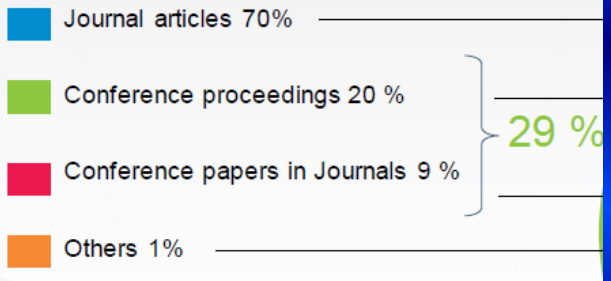
Inspec Database

15M
million records
(April 2015)

- **875,000** records added in 2014

- 1898-Present
- International Coverage
- Over 4,500 Journals and 3,000 other publications

Document Types



Others include:
- Books/Book Chapters
- Reports
- Patents (1968/9-1976)
- Dissertations
- Video

47 Numeric Indexing fields are searchable in Inspec, including…

- Size (meters)
- Distance, Depth, Altitude (meters)
- Mass (kilograms)
- Time (seconds)
- Temperature (Kelvin)
- Velocity (meters per second)

- Computer speed (FLOPS)
- Memory size (bytes)
- Storage capacity (bits)
- Bandwidth (Hertz)
- Bit rate (bits per second)
- Byte rate (bytes per second)
- Picture size (pixels)

- Power (watts)
- Voltage (volts)
- Resistance (ohms)
- Current (amperes)
- Capacitance (Farads)
- Conductivity (Siemens per meter)
- Frequency (Hertz)
- Energy (Joules)

- Gain, Loss (decibels)
- Frequency (Hertz)
- Noise figure (decibels)
- Wavelength (meters)

…and More!

- Geocentric distance (meters)
- Heliocentric distance (Astronomical Units)
- Galactic distance (parsecs)
- Stellar mass, Solar mass

Search Format Example

Search for “5 Kilobytes (5,000 bytes)”:

nims(5E3)

*[*See the ProSheet for Inspec*]*
The Field Code for **Memory size** is **nims** (Numeric Index – memory size), in bytes

5,000 bytes, expressed in Exponential format, is 5E3 (5, plus 3 decimal places)

A Note on Number Formats

For simplicity, here we are using a format like…for 5 kilobytes (5,000 bytes) of memory size:

nims(5E3) ← *Best **Search** format*

…but, FYI: you would get the same hits with any of these:

nims(5E3)

nims(5.0E3)

nims(5.0E+3)

nims(5.0E+03) ← *Format **displayed** in records*

See ProSheet for search examples. The ProSheet says that the zeroes here are "optional," and recommends that you **NOT** use the "**+**" when searching.

Note: Number before “E” is always less than 10.
(If 10 or more, the number after E goes up.)

- 1 Megawatt= 1,000,000 watts - nipo(1E6)

6 decimal places

- 10 Megawatts= 10,000,000 watts - nipo(1E7)

7 decimal places

- 100 Megawatts= 100,000,000 watts - nipo(1E8)

8 decimal places

Note: Number before “E” can, where appropriate, use a decimal point plus more digits -- e.g.:

- 1 Megawatt= 1,000,000 watts - nipo(1E6)

  6 decimal places

- 1.5 Megawatts= 1,500,000 watts - nipo(1.5E6)

  6 decimal places

- 15 Megawatts= 15,000,000 watts - nipo(1.5E7)

  7 decimal places

- 175 Megawatts= 175,000,000 watts - nipo(1.75E8)

  8 decimal places

Search Format - Example #2

Search for “5 millimeters (5/1000 meters, or **.005 meters**) or less”:

nisi(<=5E-3)

*[*See the ProSheet for Inspec*]*
The Field Code for **Size**
is **nisi** (Numeric Index – Size), in meters

.005 meters, expressed
in Exponential format,
is 5E-3 (5, **minus** 3 decimal places)

Exponential numbering

- Similar to “Scientific Notation” or “Standard index form” notation – but here, we’ll look at the numbering format as it’s used in Inspec’s Numeric Index searching.

Why Exponential numbering?

Uniform and standardized. For example, “**5 Gigawatts**” might appear in a record, using plain language, as any of these:

- 5 Gigawatts
- 5 GW
- 5,000 Megawatts
- 5,000 MW
- 5,000,000 Kilowatts
- 5,000,000 KW
- 5 million kilowatts
- 5 billion watts
- 5,000,000,000 watts
- (etc)

…but no matter which way the amount “**5 Gigawatts**” might be formatted in a record, it can be searched in the Numerical Index field as:

nipo(5E9)

Exponential (Scientific) Notation

2.7E4 means 2.7×10^{4} =

2.7000 =

27000.0

2.7E-4 means 2.7×10^{-4} =

0002.7 =

0.00027

Exponential numbering

1,000,000,000,000	10^{12}	1.00E+12	or	1E12	terra (T)	(trillions)
1,000,000,000	10^{9}	1.00E+9	or	1E9	giga (G)	(billions)
1,000,000	10^{6}	1.00E+6	or	1E6	mega (M)	(millions)
1000	10^{3}	1.00E+3	or	1E3	kilo (k)	(thousands)
1	10^{0}	1.00E+0	or	1E0		
0.01	10^{-2}	1.00E-2	or	1E-2	centi (c)	(hundredth)
0.001	10^{-3}	1.00E-3	or	1E-3	milli (m)	(thousandth)
0.000001	10^{-6}	1.00E-6	or	1E-6	micro (μ)	(millionth)
0.000000001	10^{-9}	1.00E-9	or	1E-9	nano (n)	(billionth)

			Scientific Notation		
Prefix	Symbol	Multiplier	Exponential	Normalized	E Notation
yotta	Y	1,000,000,000,000,000,000,000,000	10^{24}	1.0×10^{24}	$1.0E^{24}$
zetta	Z	1,000,000,000,000,000,000,000	10^{21}	1.0×10^{21}	$1.0E^{21}$
exa	E	1,000,000,000,000,000,000	10^{18}	1.0×10^{18}	$1.0E^{18}$
peta	P	1,000,000,000,000,000	10^{15}	1.0×10^{15}	$1.0E^{15}$
tera	T	1,000,000,000,000	10^{12}	1.0×10^{12}	$1.0E^{12}$
giga	G	1,000,000,000	10^{9}	1.0×10^{9}	$1.0E^{9}$
mega	M	1,000,000	10^{6}	1.0×10^{6}	$1.0E^{6}$
kilo	k	1,000	10^{3}	1.0×10^{3}	$1.0E^{3}$
hecto	h	100	10^{2}	1.0×10^{2}	$1.0E^{2}$
deca	da	10	10^{1}	1.0×10^{1}	$1.0E^{1}$
		1	10^{0}	1.0×10^{0}	$1.0E^{0}$
deci	d	0.1	10^{-1}	1.0×10^{-1}	$1.0E^{-1}$
centi	c	0.01	10^{-2}	1.0×10^{-2}	$1.0E^{-2}$
milli	m	0.001	10^{-3}	1.0×10^{-3}	$1.0E^{-3}$
micro	μ	0.000001	10^{-6}	1.0×10^{-6}	$1.0E^{-6}$
nano	n	0.000000001	10^{-9}	1.0×10^{-9}	$1.0E^{-9}$
pico	p	0.000000000001	10^{-12}	1.0×10^{-12}	$1.0E^{-12}$
femto	f	0.000000000000001	10^{-15}	1.0×10^{-15}	$1.0E^{-15}$
atto	a	0.000000000000000001	10^{-18}	1.0×10^{-18}	$1.0E^{-18}$
zepto	z	0.000000000000000000001	10^{-21}	1.0×10^{-21}	$1.0E^{-21}$
yocto	y	0.000000000000000000000001	10^{-24}	1.0×10^{-24}	$1.0E^{-24}$

2 Ways to Search Using Ranges

- Broader (more common method): Results with at least one value within searched range; or results with ranges that overlap with searched range
- Narrower: All results must be within searched range (use NOT to exclude records where any value in record is too high or too low)

Use case #1

Find articles re: issues of lightning strikes to poles or towers, between 500-600 meters high

- *[per ProSheet]* Field is **nisi** (size, in meters)
- “500” is 5E2; “600” is 6E2

(lightning n/10 (pole or tower)) and nisi(5E2 - 6E2)

space **hyphen** space

As shown on ProSheet: To search for a range, separate your 2 Numeric Index values with “space **hyphen** space”

(lightning n/10 (pole or tower)) and nisi(5E2 - 6E2)

- *Gets 4 hits. Each discusses lightning strikes to a tower of a specific height, namely 553 meters or 546 meters*

Excerpts from 4 records retrieved:

Application of the antenna theory model to a tall tower struck by lightning
Abstract (English): The interaction of lightning with the **553-m high** CN Tower in Toronto …
Numeric indexing: size: **5.53E+02 (m)**

Lightning electric field characteristics of first and subsequent return strokes to a tall tower
Abstract (English): Simulation of electric fields associated with lightning return stroke (RS) currents of hashes to a tall structure (the Toronto **553 m** CN Tower) …
Numeric indexing: size: **5.53E+02 (m)**

A finite-difference time-domain approach for the evaluation of electromagnetic fields radiated by lightning strikes to tall structures
Abstract (English): … (i) a lightning strike to ground, and (ii) a lightning strike to a 168 -m tall tower, and (iii) a lightning strike to a **553 -m tall** tower
Numeric indexing: size: **5.53E+02 (m)**

Electromagnetic field associated with lightning return strokes to a tall structure: influence of channel geometry
Abstract (English): … For a few characteristic cases of non-vertical channel orientation, E- and H-fields produced at 2 km distance by a lightning strike to the CN tower (**546-m height**) are computed
Numeric indexing: size: **5.46E+02 (m)**

Use case #2

Find articles mentioning: Intel computer processors between 1.5Ghz and 2.7 Ghz

- *[per ProSheet]* Field is **nifr** (frequency, in Hertz)
- “1.5 Giga” is 1.5E9; “2.7 Giga” is 2.7E9

Intel and (processor or cpu) and nifr(1.5E9 - 2.7E9)

As shown on ProSheet: To search for a range, separate your 2 Numeric Index values with “space **hyphen** space”

Intel and (processor or cpu) and nifr(1.5E9 - 2.7E9)

space hyphen space

- *Gets 94 hits. Each discusses an Intel processor with frequency in the searched range, e.g.:*

  1.6 GHz, 1.8 GHz, 2.33 GHz, 2.6 GHz

Excerpts from retrieved records

A sub-2 W low power IA processor for mobile Internet devices in 45 nm high-k metal gate CMOS
Abstract (English): This paper describes a low power Intel® Architecture (IA) processor specifically designed for mobile internet devices (MID) **…**at a frequency of **1.86 GHz**
Numeric indexing: frequency: 1.86E+09 (Hz) …

Hardware architecture for full analytical Fraunhofer computer-generated holograms
Abstract (English): …of a personal computer with an Intel i5-3230M **2.6 GHz** CPU for a triangular object.
Numeric indexing: frequency: 2.6E+09 (Hz)

An Implementation of Parallel 2-D FFT Using Intel AVX Instructions on Multi-core Processors

Abstract (English): …We successfully achieved a performance of over 61 GFlops on an Intel Xeon E5-2670 (**2.6 GHz**, two CPUs, 16 cores) and over 24 GFlops on an Intel Core i7-3930K (3.2 GHz, one CPU, six cores) for a 212 × 212-point FFT.

Numeric indexing: frequency: **2.6E+09 (Hz)** frequency: 3.2E+09 (Hz)

Note, this record discusses 2 separate processors. One has a nifr value within the searched range, while the other is **outside** the searched range

The Xeon® Processor E5-2600 v3: a 22 nm 18-Core Product Family

Abstract (English): … The design supports a wide range of configurations including thermal design power ranging from 55 to 160 W and frequencies ranging from **1.6** to 3.7 GHz. …

Numeric indexing: frequency: 1.6E+09 to 3.7E+09 (Hz)

Note, this record shows a **range** of nifr values – the lower end is within our searched range, although the higher end is not

What Do “Range Searches” Retrieve?

A simple “range search” will retrieve records containing a Numeric Index value which:

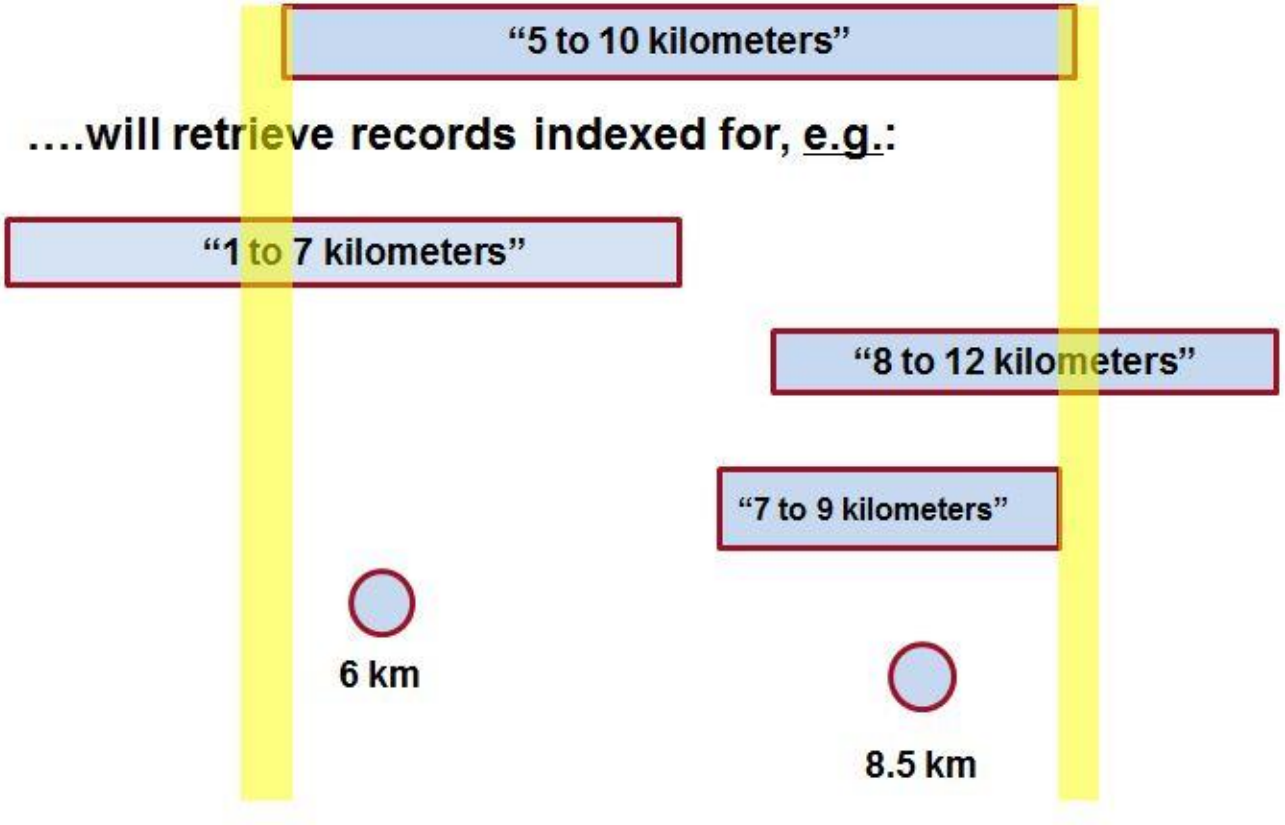
- Falls completely within the searched range

OR,

- Shows a range that “overlaps” the searched range

Search for “5 to 10 kilometers”, using

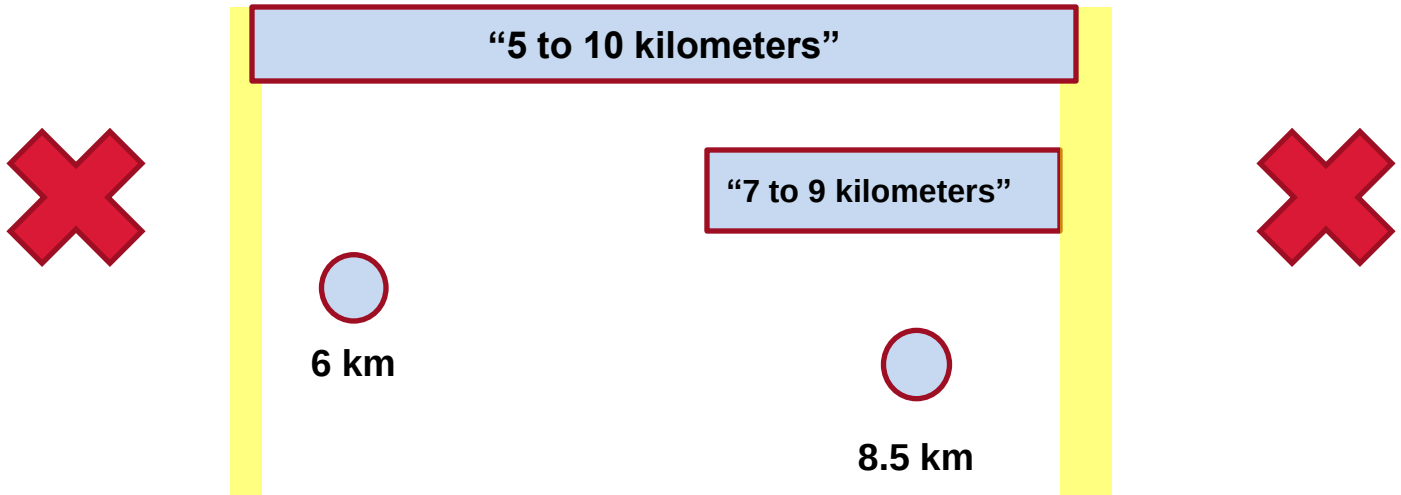
nisi(5E3 - 1E4)…



To get ONLY records where the Numeric Index falls completely within your searched range:

If you prefer, you can limit to records that "fall within" your range, by "notting-out" any lower or higher values:

nisi(5E3 - 1E4) NOT (nisi(<5E3) or nisi(>1E4))



Also: Numeric Index search for a single value, can retrieve records that contain a “range”

Remember, **you can also do the “opposite”** of what we’ve looked at:

You can do a Numeric Index search for a single, specific number, and get records that are indexed by either:

- That same, specific number value

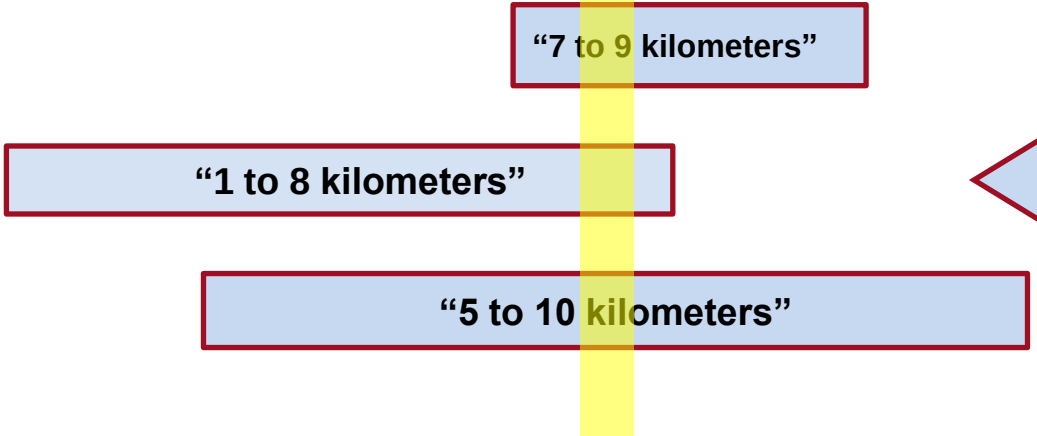
OR,

- Any range that “includes” the searched number

Search for “7.5 kilometers”, using Numeric Indexing

nisi(7.5E3)

….will retrieve records indexed for, e.g.:



NOTE, you might “miss” all these records if, instead of using Numeric Index **nisi(7.5E3)**, you had just done a plain text search for “7.5 kilometers”

Use case #3 (LIVE DEMO)

Find articles re: Noise issues from small-power wind turbines (10 kilowatts or under, the size used for homes)

- *[per ProSheet]* Field is **nipo** (power, in watts)
- “10 kilo” is 1E4
- Use “<=” to search for “less than or equal to”

(LIVE DEMO SUMMARY)

- *In Inspec, use Thesaurus to identify terms re: wind-power (I began with term “windmill”); run search for those terms (creating S1)*
- S1 AND noise AND nipo(<=1E4)
- View results; Export as Citation/Abstract, or in a Custom format that includes the Title and Numeric Index fields

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Thank you...