# Thermo Scientific iCAP 7000 Series ICP-OES Instrument Detection Limits


## Key Words
Instrument Detection Limits, Method Detection Limit


## Goal
The Thermo Scientific™ iCAP™ 7000 Series ICP-OES is a range of powerful, high performance Inductively Coupled Plasma – Optical Emission Spectrometers (ICP-OES) that deliver high sample throughput, application flexibility and low cost of ownership.

## Introduction
Elemental analysis is one of the most frequent determinations carried out in the modern laboratory and involves the quantification of various elements by wet chemical or spectrometric techniques. Modern spectrometric techniques have speed and detection capabilities far beyond most classical wet chemical methods. The speed capabilities maximize sample throughput and low detection limits expand the scope of applicable areas of analysis. ICP-OES has become one of the most popular elemental analysis techniques with simultaneous multi-element capabilities facilitating high sample throughput and detection limits in the ppb or sub-ppb range for most elements.

## Detection Limits
Detection limits are key indicators of an instrument's capabilities; useful as an aid in determining its suitability for a chosen task. They demonstrate the lowest level of analyte distinguishable from the background noise under optimal conditions and are typically determined several times to improve the statistical accuracy. As a comparison between instruments, detection limits provide useful indicators to the laboratory chemist either in the decision process for instrument acquisitions or as a measure of performance for current instruments. Detection limits can be defined as Instrument Detection Limit (IDL) and Method Detection Limit (MDL).

An IDL is a generic value that defines the lowest concentration of an analyte that can be detected under ideal conditions; and normally measured on a single element basis, using clean sample e.g. ultrapure water. An MDL determines the lowest level of analyte that can be detected in a sample matrix using the proposed method of analysis. They are usually determined on a multi-element basis using diluted standard solutions at concentration levels that can no longer be accurately read, or by adding a low concentration spike into a real sample. There are numerous procedures for determining and calculating the MDL, but most methods require numerous analytical runs, over several days, to ensure a realistic determination.

## Typical Detection Limits
Typical detection limits are measured on several instruments of the same type to assess the average level of performance that can be expected. Due to minute variations in optical components and instrument set up, data for any given instrument may differ slightly from these values. The typical detection limits, presented in table 1, are the IDLs of an Thermo Scientific iCAP 7000 Series ICP-OES as determined by applications chemists in a standard laboratory and are an excellent indication of what is achievable with the instrument. The detection limits were determined on an iCAP 7000 Series ICP-OES using standard sample introduction components, consisting of a concentric nebulizer and cyclonic spraychamber.

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## Detection Limit Determination

To determine the detection limit for an element, a standard of 50-times the expected value and a blank were prepared. The instrument was allowed to stabilize and then 10 measurements of each solution were taken using 15 second integration times. The detection limits were calculated using the raw intensity data from the standard and the blank as follows:-

$$IDL = 3\ SD_{blk} \times \frac{STD_{conc}}{STD_x - BLK_x}$$

Where:

IDL is the instrument detection limit

$SD_{blk}$ is the standard deviation of the intensities of the multiple blank measurements

$STD_x$ is the mean signal for the standard

$BLK_x$ is the mean signal for the blank

$STD_{conc}$ is the concentration of the standard

The multiplier of three is based on the student's t-test table and shows that a confidence interval of 99% is used to calculate the detection limit.

Table 1. Instrument detection limits

*Not applicable to the Thermo Scientific iCAP 7200 ICP-OES

| Element | Wavelength (nm) | iCAP 7000 Series Duo (axial view) DL µg/l (15s) | iCAP 7000 Series Radial DL µg/l (15s) |
|---|---|---|---|
| **Ag** | 328.068 | 0.32 | 2.46 |
| **Al** | 167.079* | 0.12 | 1.51 |
| **Al** | 308.215 | 4.10 | - |
| **As** | 189.042 | 1.43 | 4.74 |
| **Ba** | 455.503 | 0.03 | 0.17 |
| **Be** | 311.107 | 0.017 | 0.07 |
| **Ca** | 393.366 | 0.003 | 0.02 |
| **Cd** | 214.438 | 0.07 | 0.19 |
| **Co** | 228.616 | 0.51 | 1.16 |
| **Cr** | 205.560 | 0.21 | 0.85 |
| **Cu** | 324.754 | 0.39 | 2.36 |
| **Fe** | 259.940 | 0.25 | 0.80 |
| **Hg** | 184.950 | 0.14 | 1.10 |
| **K** | 766.490 | 0.6 | 5.10 |
| **Li** | 670.784 | 0.03 | 0.83 |
| **Mg** | 279.553 | 0.01 | 0.04 |
| **Mn** | 257.610 | 0.07 | 0.21 |
| **Mo** | 202.030 | 0.38 | 1.11 |
| **Na** | 589.592 | 0.37 | 1.80 |
| **Ni** | 231.604 | 0.36 | 2.29 |
| **P** | 177.495 | 1.55 | 5.66 |
| **Pb** | 220.353 | 1.06 | 4.50 |
| **S** | 180.731 | 1.05 | 2.22 |
| **Sb** | 206.833 | 3.25 | 9.36 |
| **Se** | 196.090 | 3.05 | 7.36 |
| **Sn** | 189.989 | 1.1 | 1.57 |
| **Sr** | 407.771 | 0.01 | 0.04 |
| **Ti** | 336.121 | 0.30 | 0.58 |
| **Tl** | 190.856 | 4.4 | 7.33 |
| **V** | 309.311 | 0.23 | 0.80 |
| **Zn** | 213.856 | 0.19 | 0.60 |





*Thermo Electron Manufacturing Ltd (Cambridge) is ISO 9001:2008 Certified.*

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