

revvity

Sealed standards for  
liquid scintillation counters

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# Types of sealed standards

Revvity manufactures the following types of sealed standards for liquid scintillation counters:

| Part #   | Type  | Radionuclide                          | Vial size | Vol   | # Of vials |
|----------|---|---------------------------------------|-----------|-------|------------|
| 6008400  | Unquenched Standard Set   | Tritiated Toluene & Carbon-14 Toluene | 7 ml      | 5 ml  | 3          |
| 6008401A | Quenched Series   | Tritiated Toluene                     | 7 ml      | 5 ml  | 10         |
| 6008402A | Quenched Series   | Carbon-14 Toluene                     | 7 ml      | 5 ml  | 10         |
| 6008403A | Combined Set of $^3\text{H}$ and $^{14}\text{C}$ Quenched Series                | Tritiated Toluene & Carbon-14 Toluene | 7 ml      | 5 ml  | 2 x 10     |
| 6008411A | Unquenched Std.-Argon Purged  | None                                  | 7 ml      | 5 ml  | 1          |
| 6008412A | Unquenched Std.-Argon Purged  | Tritiated Toluene                     | 7 ml      | 5 ml  | 1          |
| 6008413A | Unquenched Std.-Argon Purged  | Carbon-14 Toluene                     | 7 ml      | 5 ml  | 1          |
| 6008500A | Unquenched Standard Set   | Tritiated Toluene & Carbon-14 Toluene | 20 ml     | 15 ml | 3          |
| 6008501A | Quenched Series   | Tritiated Toluene                     | 20 ml     | 15 ml | 10         |
| 6008502A | Quenched Series   | Carbon-14 Toluene                     | 20 ml     | 15 ml | 10         |
| 6008503A | Combined Set of $^3\text{H}$ and $^{14}\text{C}$ Quenched Series                | Tritiated Toluene & Carbon-14 Toluene | 20 ml     | 15 ml | 2 x 10     |
| 6008511A | Unquenched Std.-Argon Purged  | None                                  | 20 ml     | 15 ml | 1          |
| 6008512A | Unquenched Std.-Argon Purged  | Tritiated Toluene                     | 20 ml     | 15 ml | 1          |
| 6008513A | Unquenched Std.-Argon Purged  | Carbon-14 Toluene                     | 20 ml     | 15 ml | 1          |
| 6018551A | Quenched Series-Extended Range  | Tritiated Toluene                     | 7 ml      | 5 ml  | 10         |
| 6018552A | Quenched Series-Extended Range  | Carbon-14 Toluene                     | 7 ml      | 5 ml  | 10         |
| 6018553A | Combined Set of $^3\text{H}$ and $^{14}\text{C}$ Quenched Series-Extended Range | Tritiated Toluene & Carbon-14 Toluene | 7 ml      | 5 ml  | 2 x 10     |
| 6018594A | Quenched Series-Extended Range  | Tritiated Toluene                     | 20 ml     | 15 ml | 10         |

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| Part #   | Type   | Radionuclide                          | Vial size | Vol   | # Of vials |
|----------|--|---------------------------------------|-----------|-------|------------|
| 6018595A | Quenched Series-Extended Range   | Carbon-14 Toluene                     | 20 ml     | 15 ml | 10         |
| 6018596A | Combined Set of <sup>3</sup> H and <sup>14</sup> C Quenched Series-Extended Range        | Tritiated Toluene & Carbon-14 Toluene | 20 ml     | 15 ml | 2 x 10     |
| 6018911A | Unquenched Low Level Standard Non-purged   | Tritiated Toluene                     | 20 ml     | 10 ml | 1          |
| 6018912A | Unquenched Low Level Standard Non-purged   | Carbon-14 Toluene                     | 20 ml     | 10 ml | 1          |
| 6018913A | Unquenched Low Level Standard Non-purged   | None                                  | 20 ml     | 10 ml | 1          |
| 6018914A | Unquenched Low Level Std Set Non-purged  | Tritiated Toluene & Carbon-14 Toluene | 20 ml     | 10 ml | 3          |
| 6018917A | Low Level Quenched Series  | Tritiated Toluene                     | 20 ml     | 15 ml | 10         |
| 6018918A | Low Level Quenched Series  | Carbon-14 Toluene                     | 20 ml     | 15 ml | 10         |
| 6018919A | Combined Set of <sup>3</sup> H and <sup>14</sup> C Low Level Quenched Series             | Tritiated Toluene & Carbon-14 Toluene | 20 ml     | 15 ml | 2 x 10     |
| 6007600A | Ultima Gold Quenched Series  | Tritiated Toluene                     | 20 ml     | 15 ml | 10         |
| 6007601A | Ultima Gold Quenched Series  | Carbon-14 Toluene                     | 20 ml     | 15 ml | 10         |
| 6007602A | Combined Set of <sup>3</sup> H and <sup>14</sup> C Ultima Gold Quenched Series           | Tritiated Toluene & Carbon-14 Toluene | 20 ml     | 15 ml | 2 x 10     |
| 6007603A | Ultima Gold Quenched Series  | Tritiated Toluene                     | 7 ml      | 5 ml  | 10         |
| 6007604A | Ultima Gold Quenched Series  | Carbon-14 Toluene                     | 7 ml      | 5 ml  | 10         |
| 6007605A | Combined Set of <sup>3</sup> H and <sup>14</sup> C Ultima Gold Quenched Series           | Tritiated Toluene & Carbon-14 Toluene | 7 ml      | 5 ml  | 2 x 10     |
| 6010704A | Ultima Gold Low Level Quenched Series  | Tritiated Toluene                     | 20 ml     | 15 ml | 8          |
| 6010705A | Ultima Gold Low Level Quenched Series  | Carbon-14 Toluene                     | 20 ml     | 15 ml | 8          |
| 6010706A | Combined Set of <sup>3</sup> H and <sup>14</sup> C Ultima Gold Low Level Quenched Series | Tritiated Toluene & Carbon-14 Toluene | 20 ml     | 15 ml | 2 x 8      |
| 1215-111 | Unquenched Standard Set For 1220 Quantulus   | Tritiated Toluene & Carbon-14 Toluene | 20 ml     | 10 ml | 3          |



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| Part #  | Type   | Radionuclide                          | Vial size | Vol   | # Of vials |
|---------|--|---------------------------------------|-----------|-------|------------|
| 6010800 | OptiScint Quenched Series  | Tritiated Toluene                     | 20 ml     | 15 ml | 10         |
| 6010801 | OptiScint Quenched Series  | Carbon-14 Toluene                     | 20 ml     | 15 ml | 10         |
| 6010802 | Combined Set of <sup>3</sup> H and <sup>14</sup> C OptiScint Quenched Series           | Tritiated Toluene & Carbon-14 Toluene | 20 ml     | 15 ml | 2 x 10     |
| 6010803 | OptiScint Low Level Quenched Series  | Tritiated Toluene                     | 20 ml     | 15 ml | 8          |
| 6010804 | OptiScint Low Level Quenched Series  | Carbon-14 Toluene                     | 20 ml     | 15 ml | 8          |
| 6010805 | Combined Set of <sup>3</sup> H and <sup>14</sup> C OptiScint Low Level Quenched Series | Tritiated Toluene & Carbon-14 Toluene | 20 ml     | 15 ml | 2 x 8      |
| 6010820 | OptiScint Quenched Series  | Tritiated Toluene                     | 7 ml      | 5 ml  | 10         |
| 6010821 | OptiScint Quenched Series  | Carbon-14 Toluene                     | 7 ml      | 5 ml  | 10         |
| 6010822 | Combined Set of <sup>3</sup> H and <sup>14</sup> C OptiScint Quenched Series           | Tritiated Toluene & Carbon-14 Toluene | 7 ml      | 5 ml  | 2 x 10     |

The scintillator solution in these standards contains 4 grams of PPO and 0.25 grams of Dimethyl-POPOP per liter of toluene, except for Ultima Gold and OptiScint Quenched Series which contains Alkyl-naphthalene, PPO, and bis-MSB. The solution is flame-sealed in low activity borosilicate glass ampoules. Nitromethane is used as the quenching agent in the quenched standards sets.

For 1215-111 the scintillator solution contains 5 grams of PPO and 0.30 grams of bis-MSB per liter of xylene.



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# Calibration of standards

Revvity's standards for liquid scintillation counters are prepared from stock solutions that are calibrated against National Institute of Standards and Technology (NIST) Reference Materials. The following table provides information regarding the reference materials used:

|                                | Tritium | Carbon-14    |
|--------------------------------|---------|--------------|
| NIST Reference Material        | Toluene | n-Hexadecane |
| NIST Reference Number          | 4947C*  | 4222C**      |
| NIST Concentration Uncertainty | ±1.2%   | ± 0.81%      |

The uncertainty for Revvity Standards relative to the NIST Reference Material is computed as a percentage error (99% confidence level), using the following equation:

Uncertainty (%) =  $\sqrt{e_1^2 + e_2^2}$ , where

$e_1$  = Uncertainty of assay of stock solution relative to NIST material

$e_2$  = Uncertainty of dispensing of stock solution into ampoules

$e_1$  = 0.8% maximum (99% confidence level)

$e_2$  = 0.6% maximum (99% confidence level)

Using these values, the maximum uncertainty relative to NIST materials is ± 1%.

The total uncertainty in disintegration rate of the radionuclide in Revvity standards is computed as a percentage error (99% confidence level) using the following equation:

Total Uncertainty (%) =  $\sqrt{e_1^2 + e_2^2 + e_3^2}$ , where

$e_1$  and  $e_2$  are listed above

$e_3$  = Uncertainty in concentration of NIST reference material (%).

The maximum total uncertainty in the disintegration rate of the radionuclide is:

for Tritium Standards, ± 1.6%

for Carbon-14 Standards, ± 1.3%

\*Assayed by NIST, 4 March 1987

\*\*Assayed by NIST, 3 September 1990.

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# Uses of standards

Unquenched standards are used for verification of instrument performance. Performance is verified by making routine measurements of the appropriate standards. This data should be kept in a log for the instrument; the log provides convenient comparisons of data over an extended period of time.

- A. The Unquenched Tritium Standard is used to verify the Tritium counting region of interest for efficiency and reproducibility.
- B. The Unquenched Carbon-14 Standard is used to verify the Carbon-14 counting region of interest for efficiency and reproducibility. It is also used in some instruments to calibrate the quench indicating parameter. See your Operation Manual for details.
- C. The Background Standard is used to verify the instrument background, which could be affected by radioactive contamination, changes in environmental radiation, and electrical noise entering the counting channels. For certain instruments equipped for manual normalization, it is the normalization standard. It can be used in combination with the Tritium and Carbon-14 Unquenched Standards to establish Figures of Merit.
- D. The Low Level Unquenched Standards (PN 6018914A) are specifically designed to verify the Low Level performance of Revvity Tri-Carb® Liquid Scintillation Analyzers operating in the Low Level Count Mode or the High Sensitivity Count Mode. These standards should not be used during System Normalization and Calibration (SNC) since the instrument is calibrated using argon purged unquenched standards. The Low Level Standards are for use only in the performance monitoring of the Low Level Count Mode or the High Sensitivity Count Mode. Revvity warrants Low Level Unquenched Standards for 16 months from the date of assay. The useful life of the standards should be at least 12 months from the delivery date. However, replacement is required if counting efficiencies degrade significantly in low level count mode.
- E. The Low Level Quenched Series (PN 6018917A and 6018918A) are designed for use when counting samples in a classical (non Ultima Gold or non OptiPhase Hi-Safe) cocktail. Revvity warrants Low Level Quenched Standards for 16 months from the date of assay. The useful life of the standards should be at least 12 months from the delivery date. However, replacement is required if counting efficiencies degrade significantly in low level count mode.
- F. The Ultima Gold Quenched Series (PN 6007600A, 6007601A, 6007603A and 6007604A) and Ultima Gold Low Level Quenched Series (PN 6010704A and 6010705A) are designed for use in counting samples in an Ultima Gold family cocktail in Normal Count Mode or High Sensitivity/Ultra Low Level Count Mode respectively. Revvity warrants the performance of the Ultima Gold Quenched Standards for 2.5 years from the date of assay. The useful life of the standards should be at least 2 years from the delivery date. However, replacement is required if counting efficiencies degrade significantly in low level count mode for PN 6010704A and 6010705A. For optimum life, the recommended storage temperature is 4° C.
- G. The Unquenched standard set for 1220 Quantulus 1215-111 is designed for performance checks with the Quantulus.

A series of quenched standards is used to establish a correlation between the counting efficiency in a region of interest and a quench indicating parameter (QIP). The QIP can be Sample Channels Ratio (SCR), Sample Count Ratio (SCR), Spectral Index of Sample (SIS) or a parameter based on an external standard measurement. External standard parameters include External Standard Channels Ratio (ESR), the Spectral Index of External Standard (SIE), or the Transformed Spectral Index of External

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Standard (tSIE). Efficiency correlation curves determined with these standards will apply to a wide variety of scintillation solutions. Applicability of the efficiency correlation to any specific scintillator solution should be determined in the laboratory. This is accomplished by comparing the correlation curves of the standards and the scintillator solution containing a known amount of the same radionuclide. Use of the sealed standards simplifies routine checking of the efficiency correlation curves since sample preparation is eliminated.

For instrument settings and procedures for establishing efficiency correlation curves, refer to the operation manual for the instrument or contact the instrument manufacturer.

The following are signs that may indicate that the standards are not suitable for the uses as described above.

1. An obvious difference in the height of the scintillation solution in one or more of a set of standards may indicate a break in the seal, and leakage of the standard.
2. Readings on one standard that are obviously out of line with other standards in the set.
3. Unquenched standards in a set should all have essentially the same external standard readings.
4. Quenched standards in a series (except the Ultima Gold Series) are marked in alphabetical sequence relative to their external standard values. ("A" represents the least quenched sample.) The Ultima Gold Series standards are marked numerically. (#1 represents the least quenched sample).

5. Obviously discolored scintillator solution in one or more standards.  
CAUTION: Standards should not be exposed to sunlight or UV light as this can cause solution to turn yellow.
6. Obviously scratched or dirty ampoules.

The assayed value of a standard should be corrected for decay if the standard is used after 0.5% of the half-life of the radionuclide has elapsed since calibration. At this interval, the required correction will exceed one standard deviation of the assayed value. See the last page of this booklet for a Tritium decay table listing the fraction of the activity remaining after date of calibration. Carbon-14 Standards should not need to be corrected for decay.

Standards should be handled by their tops to minimize accumulation of dirt on the ampoule surface. All fingerprints and dirt should be wiped from each standard with a soft tissue. Standards should be stored in the cabinet of the TRI-CARB® Liquid Scintillation Counter to ensure temperature equilibration and to prevent photolytic decomposition by ambient light.



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# Useful life of a standard

A sealed standard should not be used beyond its “useful life” as defined in ANSI Standard N42. 15-1980: “‘Useful life’ is a period not to exceed five years.” The Low Level unquenched and quenched sealed standards have a shorter shelf life. Refer to the previous section entitled “Uses of Standards” for details.

Additional Radiation Safety Precautions and Instruction Relating to the Handling, Use, Storage, and Disposal of the Radioactive Material in Revvity Products. (Per Title 10 Code of Federal Regulations (CFR) 32.19 (d) (3))

## 1. Handling

Although the amount of radioactive material in Revvity sealed source standards is extremely small (fractions of a microcurie), the user should still exercise the basic radiation safety principles of time, distance, and shielding. That is, a) do not handle the radiation source longer than needed to do the task, and b) recognize that distance from the radiation source and c) shielding (such as lead foil) are effective methods of minimizing exposure.

Use should be only by responsible persons in authorized areas.

Eating, drinking, smoking and the application of cosmetics should be prohibited in areas of use.

## 2. Storage

Any product labeled as “Radioactive Material” is to be secured in safe storage when not in use. Even when actual hazard does not exist, the general public has an apprehension against seeing such labeled items in non-controlled environments. In addition, there is always danger of loss or theft when sources are unsecured.

## 3. Disposal

These license-exempt quantity radioactive standards may be disposed of without regard to their radioactive content provided all radiation symbols have been removed or defaced; however, these products must be disposed of according to applicable Federal, State and Local regulations governing the toxic and hazardous properties of the products.

The user instructions with this product are very specific for nuclear detection equipment quality control purposes. It is therefore reasonable to assume that the user has already been trained in radiation safety precautions or is operating under the supervision of a person with such training. In the event there are any questions relating to the handling, use, storage, and disposal of the license-exempt quantities contained in this product, please feel free to contact your customer care representative. You may call the Nuclear Regulatory Commission, Agreement State (Health Department), or Licensing State for assistance in unusual cases.



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# Certification

Revvity certifies that the standards it produces are at the activity stated on the label at the time of calibration, within the limits of uncertainty stated in this booklet.

| TRITIUM DECAY TABLE (FRACTION REMAINING) Half-life 12.43 Years <sup>1</sup> |        |        |        |        |        |        |        |        |        |        |        |        |        |
|---|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| MONTHS <sup>3</sup>   |        |        |        |        |        |        |        |        |        |        |        |        |        |
|   |        | 0      | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     |
| Y<br>E<br>A<br>R<br>S <sup>2</sup>  | 0      | 1      | 0.9954 | 0.9908 | 0.9862 | 0.9816 | 0.977  | 0.9725 | 0.968  | 0.9635 | 0.959  | 0.9546 | 0.9502 |
|   | 1      | 0.9458 | 0.9414 | 0.937  | 0.9327 | 0.9284 | 0.9241 | 0.9198 | 0.9155 | 0.9113 | 0.907  | 0.9028 | 0.8986 |
|   | 2      | 0.8945 | 0.8903 | 0.8862 | 0.8821 | 0.878  | 0.8739 | 0.8699 | 0.8659 | 0.8618 | 0.8578 | 0.8539 | 0.8499 |
|   | 3      | 0.846  | 0.842  | 0.8381 | 0.8343 | 0.8304 | 0.8265 | 0.8227 | 0.8189 | 0.8151 | 0.8113 | 0.8076 | 0.8038 |
|   | 4      | 0.8001 | 0.7964 | 0.7927 | 0.789  | 0.7854 | 0.7817 | 0.7781 | 0.7745 | 0.7709 | 0.7673 | 0.7638 | 0.7602 |
|   | 5      | 0.7567 | 0.7532 | 0.7497 | 0.7462 | 0.7428 | 0.7393 | 0.7359 | 0.7325 | 0.7291 | 0.7257 | 0.7223 | 0.719  |
|   | 6      | 0.7157 | 0.7123 | 0.709  | 0.7958 | 0.7025 | 0.6992 | 0.696  | 0.6928 | 0.6896 | 0.6864 | 0.6832 | 0.68   |
|   | 7      | 0.6769 | 0.6737 | 0.6706 | 0.6675 | 0.6644 | 0.6613 | 0.6582 | 0.6552 | 0.6522 | 0.6491 | 0.6461 | 0.6431 |
|   | 8      | 0.6401 | 0.6372 | 0.6342 | 0.6313 | 0.6284 | 0.6254 | 0.6225 | 0.6197 | 0.6168 | 0.6139 | 0.6111 | 0.6083 |
|   | 9      | 0.6054 | 0.6026 | 0.5998 | 0.5971 | 0.5943 | 0.5915 | 0.5888 | 0.5861 | 0.5833 | 0.5806 | 0.5779 | 0.5753 |
|   | 10     | 0.5726 | 0.5699 | 0.5673 | 0.5647 | 0.5621 | 0.5595 | 0.5569 | 0.5543 | 0.5517 | 0.5491 | 0.5466 | 0.5441 |
|   | 11     | 0.5415 | 0.539  | 0.5365 | 0.5341 | 0.5316 | 0.5291 | 0.5267 | 0.5242 | 0.5218 | 0.5194 | 0.517  | 0.5146 |
| 12  | 0.5122 | 0.5098 | 0.5074 | 0.5051 | 0.5027 | 0.5004 | 0.4981 | 0.4958 | 0.4935 | 0.4912 | 0.4889 | 0.4867 |        |

<sup>1</sup>Unterweger, M.P., B.M.Coursey, F.J. Schima and W.B. Mann, Int. J. Appl. Radiat. And Isot. 31,611 (1980)

<sup>2</sup>1 Year = 365.25 days

<sup>3</sup>1 month = 365/12 = 30.44 days

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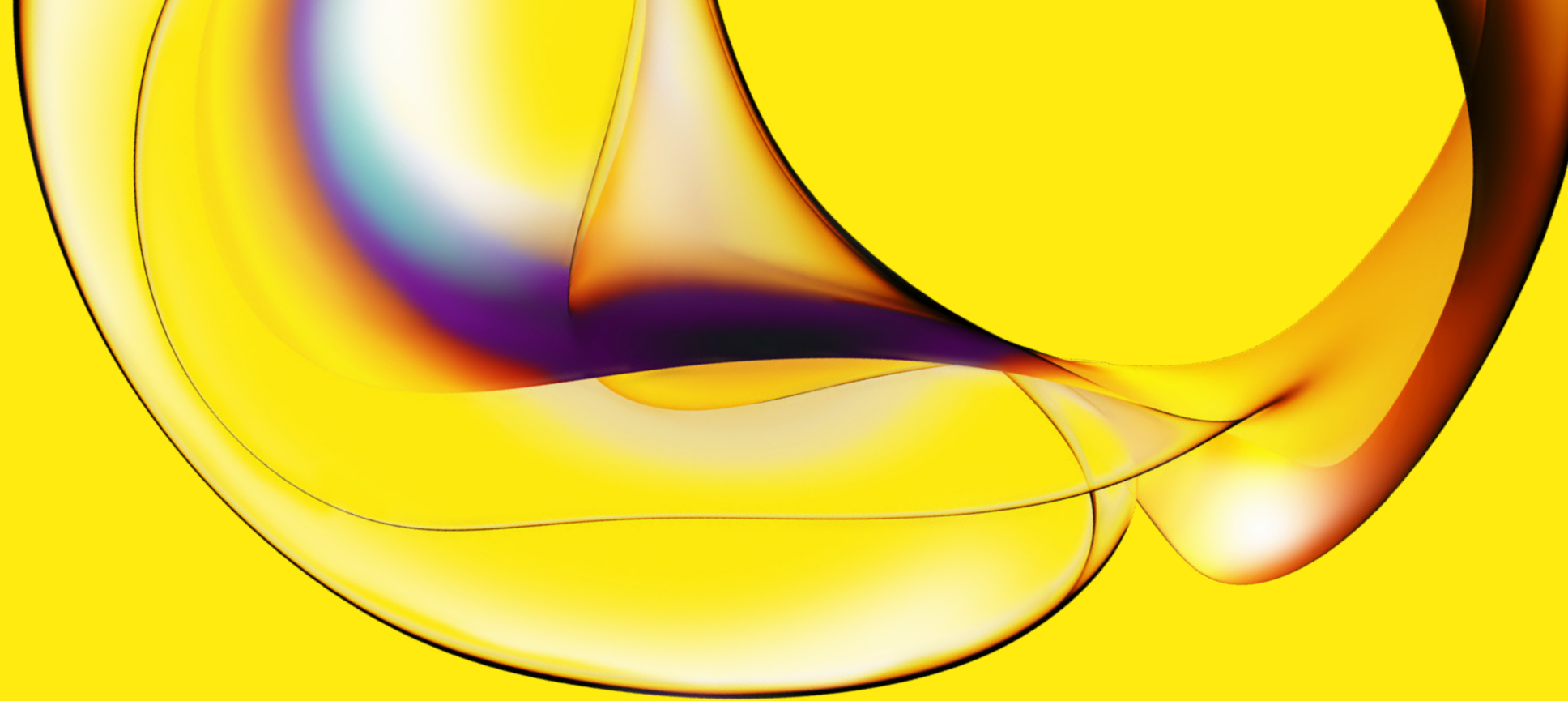
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