Ergon Energy Corporation Limited

Specification for Engineering Survey Works

Sub Transmission Standards

This Material is made available on the basis that it may be necessary for a Registered Surveyor with an appropriate endorsement to undertake the survey requirements to meet statutory obligations.
All Surveys shall be conducted according to the requirements defined in the Department of Natural Resources and Mines Survey Requirements. It is the Surveyors responsibility to ensure they hold any registration required by the Surveyors Act in order to undertake the work. In addition, they shall be conducted according to the accepted current practices of the Registering Authority. The type of engineering survey to be effected will be nominated by the Principal.
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1. **Purpose and Scope**

1.1 This Specification is compiled for the guidance and direction of surveyors concerned with the control and execution of surveys for Sub Transmission and Transmission Lines. Its purpose is to ensure uniformity in the conduct of line surveys; to describe and define the information that must be obtained; and to establish uniform standards for the recording and presentation of survey information.

1.2 The Specification is principally directed towards the conduct of the Engineering Survey of the Sub Transmission and Transmission Lines. When easement surveys are affected, they shall be conducted according to the requirements defined in the Ergon Energy Specification for Easement Survey Works and the Department of Natural Resources and Mines Survey Requirements. In addition, they shall be conducted according to the accepted current practices of the Registering Authority. The type of easement survey to be effected will be nominated by the Principal.

1.3 All information shall be supplied in the following format:-

- **Datum** - Geocentric Datum of Australia (GDA94) in the applicable Zone
- **Elevation** – Australian Height Datum (AHD) values based on AUSGeoid98
- **Feature Codes** - Ergon Energy Pty Ltd supplied feature codes
- **CAD Drawing Layers** – All points to be layered to their feature code

2. **References**

2.1 **Ergon Energy controlled documents**

- [RSC04](#) – Clearing and Access Works

2.2 **Other sources**

- 2.2.1 Surveyors Act 2003
- 2.2.2 Survey and Mapping Infrastructure Act 2003.
- 2.2.3 Department of Natural Resources and Mines Survey Requirements
- 2.2.4 Survey and Mapping Regulations and Standards
3. Definitions, Acronyms, and Abbreviations

3.1 Definitions

3.1.1 Sub Transmission: Voltages of 33 000 volts up to, and including, 110 000 volts.

3.1.2 Transmission: Voltages of 132 000 volts and above.

3.1.3 Conductor: Wires used on powerlines.

3.1.4 Principal: For the purposes of this specification the Principal shall be Ergon Energy Pty Ltd unless stated otherwise.

3.1.5 Tee-Off: A location where the conductors may head off in a different direction whilst the main line continues on its current path. The conductors will be joined to the main line at this point.

3.1.6 Undercrossing: A location where conductors may come from a different direction or source and are not joined to the current line.

3.1.7 Span: Conductor distance between two adjoining poles.

3.1.8 Stay Wires: Wires used as guys to help hold the conductor and wind loads. These wires will typically radiate from the pole to ground or from the pole to a bollard pole.

3.1.9 Feature Code: Alpha or Numeric codes used to identify and record the type of point surveyed.

3.1.10 Geo-referenced: Aligned to its real world location.

3.1.11 LIDAR: Light Detection and Ranging. For the purposes of this Specification it will be the aerial survey method which uses lasers mounted on aircraft to record information over the line route at a nominated swath width.

3.2 Acronyms and Abbreviations

The following Acronyms appear in this Specification.

POA  Point of attachment. e.g. The point where a conductor attaches to an insulator.

OHEW  Overhead Earthwire. For the purposes of this specification, this shall also include Optical Ground Wires (OPGW).

PLS-CADD™  Power Line Systems – Computer Aided Design and Drafting. Overhead line design Software used by the Ergon Transmission Design section.

CAD  Computer Aided Drafting. Software packages used for general drafting work.

AHD  Australian Height Datum
4. Security

Nil

5. Safety, Environmental and Cultural Heritage Considerations

5.1 Safety

Refer to the Project Safety Plan provided by the Project Manager.

5.2 Environmental and Cultural Heritage

Refer to the Principal’s Project Management Plan supplied by the Project Manager.

The Principal requires all work to be undertaken in an environmentally sound manner. The Consultant is responsible for ensuring that the Principal’s requirements for environmental protection are implemented and the following brief outline of the environmental protection requirements for this contract is provided for the guidance of Consultants.

All vehicles, machinery and equipment to be used on the job must be certified “clean” of all declared plants and noxious weeds by the Consultant.

Should any declared plants or noxious weeds be encountered during the survey, the Consultant shall notify the Principal within 24 hours. Only necessary machinery, vehicles and equipment shall proceed through the infested area.

In areas of weed infestation, all vehicles shall be washed down as they leave the infested area and/or at property boundaries as advised. Vehicles not required to enter the weed areas shall remain on designated ‘clean’ areas or routes. Access routes, clean areas and infested areas shall be clearly identified by the Consultant and restrictions on moving between clean and infested areas shall be strictly observed.

The Consultant shall ensure that all works are planned and executed with appropriate safeguards to:

• minimise vegetation disturbance;
• minimise earthworks activities which could result in hazards for animals (e.g. pit traps);
• prevent the introduction of exotic species and diseases;
• minimise noise, dust, erosion, sedimentation, water pollution and traffic hazards;
• minimise the disturbance of natural watercourses;
• protect Aboriginal sites and artefacts in accordance with the relevant legislation, and measures to protect other heritage sites;
• minimise the effects of accommodating and servicing the Consultant’s workforce; and
• address the need for access and security arrangements and buffer zones to protect the public and the facilities.
The Consultant shall also ensure that all activities are compatible with the principles of sound environmental protection practice.

The Consultant shall comply with all the environmental requirements described above and shall make allowance for this in their tender. The total tender price will be deemed to include allowance for complying with the Principal’s environmental protection requirements.

Should the Consultant become aware of any aboriginal cultural heritage objects or areas on the route of the power line, they should not disturb the objects or areas but report them to the Project Manager as soon as possible. In this regard the requirements of the “Aboriginal Cultural Heritage Act 2004” shall be strictly observed.

6. General

6.1 Survey of Transmission Line Routes consists of three principal segments:

(a) Setting out a centre line and providing field information from which a longitudinal section can be derived and structure positions determined. The survey shall use the Ergon Feature Table (refer Appendix B) unless prior approval has been granted by Ergon. The survey must include, as a minimum, the following details where assets are existing or a new centreline is being proposed, using the Ergon feature codes:

(i) For new line routes:
   - Natural Surface levels
   - The position of changes of grade
   - Locations of cultivated areas
   - Location of property boundaries
   - Unsuitable pole locations
   - The position, diameter and height of all significant trees which have been needed to be accommodated in the line design because of Environmental, Cultural Heritage or other reasons.
   - Top of bank and Toe of bank for rivers, creeks, gullies etc.
   - Edges and centrelines of Highways, roads, tracks etc.
   - Location, and height where applicable, of any crossings or nearby features such as roads, railways, Telstra, signs, streetlights, power lines, fences etc
   - The location of any poles to which a crossing conductor connects and the POA of the conductors at each pole (i.e. poles either side of crossing)
   - The voltage of the undercrossing and a photo clearly showing the conductors attaching to the poles either side of the proposed new centreline. (Refer Figure A2 in Appendix A)
   - 3 measurements per span for each voltage (conductor) on any crossing
   - Date, Time, Wind Speed and ambient temperature of conductor shots

(ii) For existing line routes, in addition to the above requirements:
   - Over Head Earth Wire (OHEW) point of attachment (POA)
   - 33kV, 66kV, 110kV or 132kV conductors POA
   - LV, 11kV, 33kV or any other underbuilt conductors POA
   - POA of any tee-off conductors
   - The location of poles to which the tee-off connects and the POA of the conductors at this pole
- The location of any poles to which an undercrossing conductor connects and the POA of the conductors at each pole (i.e. poles either side of undercrossing)
- The voltage of the undercrossing and a photo clearly showing the conductors attaching to the poles either side of the proposed new centreline. (Refer Figure A2 in Appendix A)
- The position, diameter and height of all significant trees which have been needed to be accommodated in the line design because of Environmental, Cultural Heritage or other reasons.
- 3 measurements per span for each voltage (conductor) including Tee-offs and undercrossings
- Date, Time, Wind Speed and ambient temperature of conductor shots
- Attachment height and ground location of stay wires
- Location, and height where applicable, of any crossings or nearby features such as roads, railways, Telstra, signs, streetlights, power lines, fences etc.

(b) High quality photography, including geo-referencing data, of all structures, spans, obstacles and other relevant information.

(c) Effecting easement surveys when required. The measurements derived from either (a) or (b) or both may be utilised in effecting easement surveys as defined in the Survey and Mapping Infrastructure Act 2003 and associated Regulations and Standards.

6.2 The Principal uses PLS-CADD™ computer software to generate the design and structure location.

6.3 The reliability and economics of the design depend on the information supplied by the surveyor. To this end it is essential to record survey information in the manner specified.

6.4 This Specification is based on the use of Total Station; Semi Total Station, or GPS survey equipment, and may include aerial photogrammetric or remote sensing surveys where the output is horizontal and vertical positions with codes to describe different features. The output required is in the format specified in Section 11 and Appendix A.

6.5 In this Specification the use of word or expression “Structure” implies any support structure.

6.6 The Project Manager referred to throughout this Specification is the officer nominated by the Principal.

6.7 A Consulting Surveyor engaged to carry out any survey on behalf of the Principal shall not subcontract the instruction or any part thereof to another Consulting Surveyor or Firm without written approval from the Principal.

7. Location and Setting Out

7.1 The location of the proposed survey route is defined on the supplied approved route plan.
7.2 Attention is drawn to the importance of the dimensions shown on the route plans.

7.3 Details of preliminary survey work executed shall be recorded and supplied.

8. **Longitudinal Section**

The longitudinal section is based on a terrain model of 40m width (20m either side of the centre line).

8.1 The position of all changes of grade, significant detail, or points as required, are captured for development of the terrain model. However, as a general rule, no two consecutive centre line distance measurements should be taken more than 50 metres apart.

8.2 For the purpose of defining the centre line marks should be placed on the centre line such that they are intervisible, and at a distance no greater than 250m apart.

9. **Order of Accuracy**

The required order of accuracy in relation to this survey are as follows:

9.1 **Horizontal Distance**

Order of accuracy is related to three forms of survey.

9.1.1 **Engineering Survey Only**

Minimum horizontal accuracy – 1 in 500

Distance to pegs and survey stations should be recorded to the nearest 0.01 metres.

9.1.2 **Easement Survey Associated with Engineering Survey**

The distances obtained on the engineering survey of the centre line may be used in effecting easement surveys of various types. The order of accuracy of the engineering survey measurements should therefore be appropriate to the easement survey requirements defined in the Survey and Mapping Infrastructure Act 2003 and Surveyors Act 2003 and associated Regulations and Standards. Should this requirement not apply, separate instructions will be issued.

9.1.3 **Intermediate Shots**

Intermediate shots should be recorded to the nearest 0.1 metres. However, it is often convenient to have more accurate measurements to intersections of boundaries and other marks for comparison with real property surveys or for other purposes.

9.2 **Elevation**
The following clauses relate the order of accuracy required in elevation to:

(a) Route distance.
(b) Quality of information available for comparison of level values.

The Project Manager may require, or make arrangements for, a re-survey in sufficient detail to check the correctness of a model in terms of Paragraph 11.5, even though the vertical accuracy stated in paragraph 9.2.1 is achieved.

### 9.2.1 Vertical Accuracy

The minimum vertical accuracy for centre line distances in excess of one (1) kilometre, when compared with level values of independent control points, should be:

0.2 metres multiplied by the square root of the distance in kilometres.

### 9.3 Horizontal Angle at Intersections

The angle should be reduced to a deflection left or right, in the direction of the survey and be recorded to at least 20 seconds of arc.

### 9.4 Engineering/Detail Survey Requirements: Where Requested (Substation Sites)

Refer Substation Design Manual Section 8.5.

### 10. Field Book

10.1 For diagrammatic detail and additional information not recorded in the data recorder, a field book must be kept.

10.2 A diagrammatic representation of detail is required with a unique identifier for shots recorded with coded entries which are unable to display the detail.

10.3 Property boundaries and descriptions should be recorded wherever possible to assist spatial identification.

10.4 The original field book is to be forwarded to the Principal with the survey data to which it corresponds and thereafter will not be removed from the office.

### 11. Detail

The location and measurement of relevant detail information is essential to the design of the transmission line. Items listed in paragraph 6.1 shall be obtained as a minimum. Some of these features are described in more detail below. All points taken must contain x, y and z locations. For any fixed assets the Asset ID (pole number) must also be recorded.
11.1 Pole and span details required on existing infrastructure

11.1.1 Over-head earthwire POA: The survey shall include the height of the earthwire conductor as well as the height of the earthwire attachment.

11.1.2 Conductor POA: The survey shall include the height of the conductor as well as the height of eyebolts, crossarm kingbolts, conductor hangers or other attachment points.

11.1.3 Underbuild Conductor POA: The survey shall include the height of the conductor as well as the height of eyebolts, crossarm kingbolts, conductor hangers or other attachment points.

11.1.4 Tee-off feeder POA: Tee-off's shall be detailed in the survey with the POA of all tee-off crossarms as well as the location and span length to adjacent tee-off poles and the POA of conductors at the adjacent tee-off pole.

11.1.5 Undercrossings: All undercrossings shall be detailed in the survey with the POA of the conductors as well as the location of the poles at each end the undercrossing span. Conductor mid-span shots shall be recorded as per 11.1.6.

11.1.6 Mid-span measurements: The survey shall include the time, date, wind speed and temperature of all mid-span conductor height measurements. There shall be a minimum of 3 conductor elevation shots per span. Shots may be recorded as a ground shot with an additional height to conductor, or an x, y location with the R.L. of the conductor.

11.1.7 Staywire POA and ground location: The survey shall include the pole attachment height of all staywires in addition to the ground location of the staywire anchors.

11.2 Features Intersected by the Centre Line

11.2.1 The position and direction of all located boundaries, constructions and features crossed are to be noted. The position and height of any construction or overhead wires should be observed.

11.2.2 A major construction such as a highway, railway, road overpass, road intersection or high voltage transmission line should be detailed accurately in relation to the centre line. A surveyor must take sufficient measurements to all aerial installations such that their elevations can be determined by means of the relevant computer data entry codings.

For safety of personnel and in accordance with statutory regulations, measurements to all electrical conductors must be made by the use of indirect survey methods. Physical contact with conductors, using any type of measuring rod, tape, etc., is prohibited.
11.2.3 When crossing an existing powerline, it is necessary to obtain the height above the ground of the overhead earthwire, the highest conductor, and the height of the lowest conductor. The height of the conductors varies with change in temperature and sufficient detail to relate to the design of the intersected line is required. The date and time of the measurement together with the ambient temperature and wind speed should be recorded. The existing structures on both sides of the crossing are to be located; at these structures the following information is required; ground level, height of top and bottom conductors at the point of attachment (point where wire is attached to the insulator).

11.2.4 Highway and railway crossings require additional information as formal plans of the crossing details are forwarded by Ergon Energy to TMR and Queensland Rail. Highway crossings require Main Roads chainage usually obtained from Bench marks adjacent to the crossing point as well as detail described in 11.1.2.

Rail crossings require Railway chainage; names of sidings or stations adjacent to crossing on either side, and location and reduced level of each rail crossed.

11.2.5 Telstra underground cable locations must be recorded when crossed by the survey centreline and the location of the cable relative to the centreline must be recorded when the cable is within 15m of the centreline. At deviation points, the cable location is to be recorded within a radius of 30 m of the deviation point, this is necessary to allow staywire placement without damaging the cable.

11.2.6 Any cultivated area, Sugar Cane Bin unloading area, Sugar Cane Tramway etc. that is within 30m of the Centreline shall be accurately recorded. These areas have specific requirements for the design of the Transmission Line.

11.2.7 All Waterway Crossings shall have a recording taken at the current water level along with the time and date of the recording to allow for specific design requirements and drawings which are required to be submitted to Harbour Boards and Council Flooding studies etc.

11.3 Obstructions and Unusual Features Not Intersected by the Centre Line

All obstructions and unusual features within thirty (30) metres of the centre line must be located. The surveyor must measure the height relative to the centre line of all obstructions or features that could affect the design of the line, with particular recognition of the lateral swing of the conductor. This would include a parallel power line where each structure and its height would need to be captured. The position, diameter and height of all significant trees which have been needed to be accommodated in the line design because of Environmental, Cultural Heritage or other reasons shall be recorded.

11.4 Hill Crests

Special care is necessary to record the definition of the terrain when going over the tops of hills or spurs. Readings should be taken at a sufficient number of positions.
such that the actual profile does not deviate more than 0.3 metres from the chord between two adjacent readings.

11.5 Checking of Survey

11.5.1 The extent of the required checking of the survey will be defined by the Project Manager.

11.5.2 The checks to be applied may consist of broad overall checks for horizontal and vertical reliability, and/or detailed checks to verify that information within a span is correct for purposes of the survey.

11.5.3 The following typical broad checks may be applicable:

(a) Connection to existing vertical and horizontal control points established by others;

(b) Connection to existing vertical control points only. (See also Paragraph 11.6.)

(c) Establishment of a control transverse in association with the transmission line, either along or adjacent to the centre line;

(d) Comparison of reduced levels with existing mapped contours;

(e) Comparison of route distance with existing route mapping, especially cadastral boundaries.

11.5.4 The following method of checking detailed profile information will be required.

At the time of pegging the structures, critical points on the profile are measured, as well as the pegged span length.

11.6 Level Datum

Levels are computed in terms of Australian Height Datum within the limits of accuracy of the survey. Checks onto existing control points are utilised as a check against gross error. Frequency of these checks depends on circumstances and must be decided in association with the Project Manager.

12. Additional Data to Assist in Structure Spotting

12.1 At all stages of the survey, measured and subjective data having an impact on the location and design of structure positions should be recorded. This data may include such items as changes in vegetation types, density of vegetation, position of cattle camps and heights of trees within the camps, location and height of outstanding trees such as large fig and cedar trees, soil types and structure site accessibility.
12.2 The location and heights of trees should be measured in environmentally sensitive areas such as road crossings in tourist and scenic areas and near gullies and creeks where clearing may not be required for conductor clearance.

13. Connection to Adjoining Survey

It is the responsibility of the Surveyor to ensure that adequate connection is made to previously surveyed adjoining sections, such that a continuous terrain model can be obtained.

14. Survey Pegs

14.1 Dumpy pegs shall be used to identify the exact location of the asset installation. A dumpy peg shall also be used at a nominated offset from the asset location. Dumpy pegs that may pose a Safety Hazard to pedestrian traffic (e.g. Urban areas) are to be installed flush with the ground with no finder peg. A clearly marked offset dumpy and offset finder peg placed at an appropriate safe distance shall nominate the distance to the asset’s dumpy peg.

14.2 A finder peg shall be placed within 150mm of the dumpy peg for ease of location or for back sighting. Flagging tape the same colour as the peg shall be used on all finder pegs. Finder pegs that pose a Safety Hazard to pedestrian traffic (e.g. Urban areas) are not to be installed. A clearly marked offset dumpy and offset finder peg placed at an appropriate safe distance shall nominate the distance to the asset’s dumpy peg.

14.3 Offset pegs shall be placed at a safe distance (typically 15m in Rural areas and as required for Urban areas) from the dumpy peg to reduce the risk to pedestrian traffic and to enable restoration of an asset dumpy peg should it be removed or disturbed. The distance to the asset’s dumpy peg shall be clearly marked on the Offset peg.

**Peg sizes, colours and uses shall be as below.**

<table>
<thead>
<tr>
<th>Peg Use</th>
<th>Peg Colour</th>
<th>Peg Size</th>
<th>Additional Comments</th>
<th>Flagging Tape Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pole Dumpy Peg</td>
<td>Red</td>
<td>200x50x38</td>
<td>Pole Number to be marked on peg (e.g. PV101) as appropriate</td>
<td>N/A</td>
</tr>
<tr>
<td>Pole Finder Peg</td>
<td>Red</td>
<td>1200x50x25</td>
<td>Pole Number to be marked on peg (e.g. PV101)</td>
<td>Red</td>
</tr>
<tr>
<td>Stay Dumpy Peg</td>
<td>Blue</td>
<td>200x50x38</td>
<td>Pole &amp; Stay Number to be marked on peg (e.g. PV101S1) as appropriate</td>
<td>N/A</td>
</tr>
<tr>
<td>Stay Finder Peg</td>
<td>Blue</td>
<td>1200x50x25</td>
<td>Pole &amp; Stay Number to be marked on peg (e.g. PV101S1) as appropriate</td>
<td>Red</td>
</tr>
<tr>
<td>Pole Offset Dumpy Peg</td>
<td>Yellow</td>
<td>200x50x38</td>
<td>Peg to be marked with Pole Number followed by “OS” (e.g. PV101OS) as appropriate</td>
<td>N/A</td>
</tr>
</tbody>
</table>
### 15. Aerial Surveying

Full waveform LIDAR systems that include the entire backscatter signal of each laser pulse (and process this information to provide additional points, particularly for areas where there is vegetation cover) shall be used. Wherever the proposed centreline crosses any overhead powerlines, the closest structure and span on both side of the crossing shall be surveyed and photographed. The date, time and climatic conditions (wind speed, temperature etc) at ground level shall be recorded for any survey undertaken.

#### 15.1 Before LiDAR survey is undertaken the following shall be supplied for approval:-
- Equipment details and software capabilities
- Estimated Accuracy (minimum ±0.15m Vertical, ±0.5m Horizontal relative accuracy required)
- Point density
- Digital Terrain Model format
- Georeferenced image format
- Expected delivery timeframe

#### 15.2 Digital Terrain Model data shall be described by coordinate position and elevation. DTM data shall be comma delimited text with one record per line. The data shall be provided in the coordinate system specified in 1.3. Typical format of a record is Easting (m), Northing (m), Elevation (m), Feature Code, Comment (optional).

#### 15.3 Separate Data Files are required for the following features:-
- Bare earth terrain and surface water points (points that do not significantly add to the surface definition may be thinned)
- Conductors and structures combined (points may NOT be thinned) and structures photographed
- Vegetation
- Breaklines where appropriate

### 16. Appendices

**Appendix A - Pole and span details required on existing infrastructure**

*Figure A1, Example suspension pole, 66kV ‘wishbone’ construction with 11kV under build*
POA OF 66kV INSULATOR
(66kV TYPICALLY 4 OR 5 DISCS IN SUSPENSION)
POA OF 66kV
POA OF 66kV
CONDUCTOR - 66kV
POA OF 66kV
POA OF 66kV
POA OF X-ARM KINGBOLT,
POA OF X-ARM BRACE - 11kV
CONDUCTOR - 11kV
CROSSARM
ARM BRACE
11kV PIN INSULATOR
66kV DISC INSULATORS
POA OF 66kV
POA OF 66kV X-ARM KINGBOLT,
POA OF 66kV X-ARM KINGBOLT,
66kV CROSSARM
CONDUCTOR - 66kV
66kV DISC INSULATORS
11kV PIN INSULATOR
CROSSARM
ARM BRACE
CONDUCTOR - 11kV
66kV CROSSARM
POA OF 66kV X-ARM KINGBOLT,
POA OF 66kV X-ARM KINGBOLT,
Figure A2, Example intermediate pole, 66kV post insulators with 11kV under build, tee-off, and pilot wire

Figure A3, Example termination pole, 66kV strain construction with 11kV under build, upper and lower stays
## Appendix B – Ergon Preferred Feature Codes

<table>
<thead>
<tr>
<th>Feature Code</th>
<th>Description</th>
<th>Feature Type</th>
<th>Linetype</th>
<th>Linetype Scale</th>
<th>Layer</th>
<th>Colour</th>
<th>Use in Surface</th>
<th>Symbol</th>
<th>Symbol Name</th>
<th>Attribute Name</th>
<th>Entry Mode</th>
<th>Default Text Value</th>
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<td>TOPB</td>
<td>Top of Bank</td>
<td>Line</td>
<td>Top of Bank</td>
<td>100</td>
<td>Ground</td>
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<td>No</td>
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<td>Change of Grade</td>
<td>Line</td>
<td>Dashed 1-1</td>
<td>100</td>
<td>Ground</td>
<td>Light Grey</td>
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<td>No</td>
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<td>Optional</td>
<td>Change Grade</td>
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<td>Optional</td>
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<tr>
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Check this is the latest version before use.