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Quality Assurance In Engineering Education: Provision And Practices In Nepal

Basanta Chandra Marahatta[1], Amiya Bhaumik[2], Surendra Neupane[3]

[1]Basanta Chandra Marahatta Ph.D. Scholar, Faculty of Engineering , Lincoln University College, Malaysia.Corresponding E-mail: basantachandramarahatta@gmail.com
[2]Amiya Bhaumik, Ph.D., Professor, Founder & President, Lincoln University College, Malaysia.
[3]Surendra Neupane, Ph.D., Lincoln University College, Malaysia.

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ABSTRACT

Higher Engineering Education in Nepal was started only in 1978. With the liberal policy of the Government of Nepal, 43 private engineering colleges were established after 1994 and are in operation. Due to the globalization, the mobility of engineers from one country to another is increasing every year. International mobility of the engineers compelled engineering colleges to enhance the quality of engineering education through the introduction of various quality assurance and accreditation processes. This research paper aims to analyze provision and different practices that are being adopted by different institutions of Nepal for quality assurance in engineering education. For this purpose, different literature in regards to the quality assurance and accreditation of engineering education was collected as a secondary data and reviewed from one side, and from the other, information on quality assurance and accreditations were collected from the website and reports of colleges, universities, Nepal Engineering Council (NEC) and University Grant Commission (UGC). The colleges and universities that are providing engineering education have developed and implemented their own system for quality assurance. NEC as per its checklist is regularly monitoring engineering colleges to know whether they are keen to maintain quality of engineering education or not. UGC from another side has started quality assurance and accreditation of Higher Education Institutions based on its QAA Guideline.

KEYWORDS

Engineering, Education, Norms & Standards, Quality, Assurance, Accreditation, Globalization,

1. INTRODUCTION

From very ancient to modern, an Education is taken as basic needs like food, shelter, and other economic needs. Without Education, no society could last more than a generation. Aristotle declared that *"educated men as much superior to uneducated as the living are to the dead."*

The meaning of the Education is a conscious effort of the state towards the welfare of the growing child to mould him fit in the society, where he lives.

Engineering Education is to prepare a technically competent graduate, and to add several dimensions of broadening the knowledge of planning, implementation, controlling and communication of development projects. Engineering is the application of creativity and teamwork using math and science principles as tools to solve problems. It is "Science" to describe electromagnetic radiation, but it is "Engineering" to build a radio or TV. Engineering Education develops technically sound engineers, who can solve different technical problems through the application of creativity and teamwork using math and science principles.

There is great importance of engineering education. The engineering profession is very sensitive. One minor mistake done by an engineer can cause high casualty. Engineering is applied science. Science provides theoretical knowledge and theory of science is changed in practice by engineering. It is done through the development of new technology. The technology is changing very fast in the world. Engineers are the one who develops and uses new technology. The change of the technology is possible only through research and development activities.

Different factors like physical infrastructure of engineering institutions; Curriculum; minimum requirements of the student to apply for admission and admission procedure adopted by the institutions; qualification, experience and number of faculty involved in the institutions; laboratories and library facility; and others are considered as major determining factors of the quality of engineering education.

Some time the terms "quality control" and "quality assurance" are taken as synonymous. But they are different in meaning as well as in purpose. Quality control detects the problems that occur, while quality assurance prevents detected problems (Emeasoba, 2015).

Quality control is described as the process of ensuring a certain set level of excellence that have to be met either in service or in product. Quality Control compares the achieved results with expected. So the quality control can only be done after doing the work (Emeasoba, 2015).

Quality assurance involves different parameters like the quality of teaching personnel; quality of available instructional teaching materials, equipment, college environment, students, and quality education delivery. It includes all functions and activities that will ensure quality of the academic (teaching, curriculum, etc) and structures (buildings infrastructures etc.) which will allow an objective review of the quality of the program/instructional delivery. Quality assurance is a way of measuring, improving, and maintaining the quality of any human activity that has a value. Quality assurance principles regulate both the external and internal activities of an educational institution. It is done by expert having supervisory capacity over the person doing the work and can decide on means, methods, and materials (Emeasoba, 2015).

Quality Assurance makes sure the right things are done on right way. The aim of the both quality control and quality assurance is to improve the quality of education for all students.

The globalization and mobility have created unique opportunities for the flow of technology, knowledge and ideas of people across the borders. Engineering education has become an integral part of this globalization as engineering graduates from a country can undertake employment in another country (Harun Chowdhurya, 2013). This international mobility of engineering graduates has compelled educational institutions to enhance the quality and standard by introducing various quality assurance and professional accreditation processes. The educational institutions, employers, and professional organizations have a keen interest in the quality of education received by engineering graduates who aspire to be internationally mobile especially in today's globalised economy. This quality assurance and professional accreditation are more important for countries which rely on human resources export and import.

Quality assurance mechanisms for engineering education vary considerably from country to country ranging from strong peer-run accreditation programs to large government bureaucracies. The accreditation methods used by the Washington Accord signatory countries are considered to be the best developed and most well respected systems for the accreditation of engineering education in the world.

Engineering Education is comparatively new in Nepal. It was started only in 1978 through Institute of Engineering (IOE) under Tribhuvan University (TU). The government of Nepal, particularly, after the dawn of democracy in 1990, has given major priority to the privatization. Consequently many private institutions in educational sector have come into existence. For the first time in 1994, private engineering college was established in Nepal. Now there are 43 different private engineering colleges affiliated to four different universities. Now, there are 11 universities in Nepal. Out from 11, six are providing engineering education through their constituents and private affiliated colleges.

There are already 51 (8 constituents and 43 affiliated) engineering colleges in Nepal. Annual intake capacity of these colleges is about 9500 and about 7000 student complete engineering study each year and goes for either further study or job. Hence, the big number of engineers, the product of these engineering colleges, is performing professional practice inside and outside the country.

There are three separate governmental entity formed under separate act namely Nepal Engineering Council (NEC), Universities and University Grant Commission (UGC), who are responsible for the quality assurance and accreditation of engineering education in Nepal. The NEC was formed under Nepal Engineering Council Act 1998. In 1999, NEC has developed and approved the norms and standard to run engineering colleges. The major objective of the Norms and standard is to have basic guideline to monitor and evaluate engineering institutions to maintain quality of engineering education compatible to the international standard. The universities, providing engineering education have also their separate Norms and standard aimed at maintaining quality of engineering education at par of international standard. In 2007, UGC had established separate Quality Assurance and Accreditation (QAA) division to perform regular activities related to QAA of higher education institutions.

This research paper aims to identify provision and process adopted by different governmental and non governmental entities of Nepal and abroad to assure the quality of engineering education inside the country. This paper would be useful for the colleges and universities that are being involved in engineering education.

2. LITERATURE REVIEW

In Nepal, Nepal Engineering Council (NEC) and the concerning universities are responsible to provide approval to run the engineering colleges and monitoring and evaluation of these colleges. For this, they have their own Norms and Standard, but almost similar. The Norms and Standard of the NEC was thoroughly reviewed. Similarly, different research papers prepared by different scholars, books and technical journals about the quality assurance and factors affecting quality of engineering education and steps taken to enhance the quality of education by different colleges was collected and reviewed. Some of them are given below

In the year 1999 through Nepal Engineering Council Act-1998, NEC is vested with the formulation of norms and standards, monitoring and evaluation, and ensuring co-coordinated and integrated development of engineering education in Nepal. Some of the functions of Nepal Engineering Council to ensure maintenance of standards are (Council, 1995):

- To lay down norms and standards for courses, curricula, physical and instructional facilities, staff pattern, staff qualifications, quality instruction and examinations;
- To grant approval for starting new technical institutions and for introduction of new courses or programs in consultation with the agencies concerned;
- To take all necessary steps to prevent commercialization of technical education;
- To set-up a National Board of Accreditation to periodically conduct evaluation of technical institutions or programs on the basis of guidelines, norms and standards specified by it and to make recommendations to it or to the affiliating universities regarding recognition or de-recognition of the institutions or the programs.

Accordingly, NEC has developed and approved the norms and standard to run engineering colleges. The major objective of the Norms and standard is to have basic guideline to monitor and evaluate engineering institutions to maintain quality of engineering education compatible to the international standard.

The Norms and Standard of NEC are developed based on salient features of an engineering college with an annual intake capacity of 300 students. There are eight different indicators with weightage of each indicator as given below (NEC, 1995):

Table 1: Weightage of indicators

S.N.	Description of infrastructure	Weighted
1	Lands and building space	15%
2	Laboratory equipments	20%
3	Library books and journals	15%
4	Permanent faculty	25%
5	Administrative staff	5%
6	Faculty development program	10%
7	Furniture	5.5%
8	Other: health, sports, canteen	4.5%
Total		100%

Source: Nepal Engineering Council (1999)

In India, All India Council for Technical Education (AICTE) is responsible to provide approval to run engineering program in deferent discipline. The Norms and standard to provide approval to run the institutions and to regulate the approved institutions is developed by AICTE. In the Norms and Standard of AICTE, quantity of following six parameters are mentioned that has to be fulfilled by the engineering institutions to run the program (AICTE, 2018):

1. Land requirement
2. Built up Area of the institutions
3. Books and Journals
4. Lab Equipments
5. Faculty requirement
6. Faculty cadre and qualification

The Accreditation Board for Engineering and Technology (ABET) has been responsible for the assurance of quality in engineering education in the United States from 1932. ABET has developed in new criteria for the evaluation of engineering programs, *Engineering Criteria 2000 (EC2000),* which was implemented as the standard for accreditation from 2001 in United States. This new approach replaces previous guidelines and criteria that had become increasingly lengthy and prescriptive over

the years, and were often seen as a constraint on curricular innovation. Thereafter, all U.S. engineering departments have started to demonstrate that besides having a firm grasp of science, mathematics and engineering fundamentals, the engineering graduates must have to possess communication, multidisciplinary teamwork, and lifelong learning skills and awareness of social and ethical considerations associated with the engineering profession.

Recently, ABET has developed Criteria for Accrediting Engineering Programs 2020-2021 for Baccalaureate Level Programs. It is based on eight criteria namely Students; Program Educational Objectives; Student Outcomes; Continuous Improvement; Curriculum; Faculty; Facilities; and Institutional Support mission, (ABET, 2021). There are definitions of each criterion to get the accreditation.

Based on the facts of establishment of big number of Higher Education Institutions (HEIs) inside the country from one side and from the other not relaying these HEIs, draining of big numbers of students for getting better quality education abroad, Quality Assurance and Accreditation Division Of University Grants Commission (UGC) has developed "A Brief Guideline on Quality Assurance and Accreditation for higher education in Nepal" in 2013 (UGC, 2013). There are three sections and nine appendixes in the guideline. The first section provides general information about QAA and procedure for application. Section two describes Criteria and benchmark for QAA and Section three is about Accreditation process.

Rajendra Kumar Joshi and Milly Joshi had jointly written a paper on "Quality Assurance in Engineering Education in Nepal: Issue and Challenges" and presented in 7th International Forum on Engineering Education (IFEE2015) that was held on 17-19 March 2015 at the University of Sharjah, UAE**.** Mentioning about Quality Assurance in Engineering Education, they highlight that Strict follow of academic calendar, regular conduction of classes, students admission on merit basis, continuous internal evaluation, well equipped labs, latest journals/books, research work etc are the basic requirements of internal quality assurance of education. Above all, there should be monitoring mechanisms within the system. Quality of education is evaluated with the infrastructures and its quality, environment of teaching and learning, faculty strength, class room facilities etc. Describing about the external assurance, they highlight about the role of Curriculum Development center (CDC) under Tribuvan University (TU) which is authorized body of Nepal to provide equivalency and recognition of national and international degrees; Ministry of Education (MOE) that provides Letter of Intent (LOI) to run engineering program to the institutions and Nepal Engineering Council (NEC) that provides certificate of license to practice as an engineer within Nepal. Besides the engineering colleges within Nepal need recognition of NEC (Rajendra Kumar Joshi/Milly Joshi, 2015).

As a regulatory mechanism of quality of higher education, quality assurance focuses on both accountability and improvement, providing information and judgments (not ranking) through an agreed and consistent process and well-established criteria (UNESCO, https://elkanacenter.ceu.edu, 2007)

European Association for Quality Assurance in Higher Education (ENQA) prescribes some functions and procedures that have to be covered by higher education institutions for the operation of an internal quality assurance system. The areas of concern are as follow (ENQA, 2005):

Policy and procedures for quality assurance;

Approval, monitoring and periodic review of programs and awards;

Assessment of students;

Quality assurance of teaching staff;

Learning resources and student support;

Information systems;

Public information.

Accreditation in higher education was started from the beginning of the twentieth century in the USA. Accreditation in the United States is more than 100 years old, emerging from concerns to protect public health and safety and to serve the public interest (CHEA, 2011). The medical professions in the UK started an accreditation process of their professional education, and it was disseminated to other professions (Ramadan, 2011).

In Europe, the external quality assurance of higher education is done normally by expert agencies. In Europe the criteria and processes used by the external quality assurance agencies normally are expected to include (EAQAHE, 2005):

A self-assessment or equivalent procedure by the subject of the quality assurance process;

An external assessment by a group of experts, including, as appropriate, (a) student member(s), and site visits as decided by the agency;

Publication of a report, including any decisions, recommendations or other formal outcomes;

A follow-up procedure to review actions taken by the subject of the quality assurance process in the light of any recommendations contained in the report.

The Asian countries have started assessing and accrediting higher education institutions, following the western movement on it. India established the National Assessment and Accreditation Council (NAAC) in 1994 as an autonomous body to assess and accredit institutions of higher education. This was an outcome of the recommendations of the National Policy on Education

(1986), and the Plan of Action (POA-1992) which advocated the establishment of an independent national accreditation body. The Chinese authorities have also introduced a more strict system of quality assessment in Chinese universities - starting from "211Project" and "985 Project" -. These projects were initiated to develop high-level research and "world class" universities. Consequently in 2004 the Higher Education Evaluation Center (HEEC) was set up by the Ministry of Education. The Center implements assessment of the quality of education in all higher education institutions in 5-year cycles.

The Washington Accord began with a group of countries in1989 that agreed to have an accreditation system for undergraduate engineering degrees that was 'substantially equivalent'. Companion accords were also formed for accrediting engineering technologists, in the Sydney Accord in 2001 and for accrediting engineering technicians, in the Dublin Accord in 2002. Over the years, Accord members have been moving towards the accreditation of courses based on 'outputs' rather than on 'inputs' (for example, skills developed rather than curriculum content). They have also instituted a system of peer inspection of each other's accreditation processes.

Accreditation of engineering courses is aimed at ensuring consistency across educational institutions. The mutual recognition of Washington Accord signatories is intended to preserve consistency across national boundaries. (UNESCO, 2010)

3. METHODS

The study is descriptive and is based on an analysis of available secondary sources of information on quality assurance and accreditation activities in the Nepalese context of higher education system. Such information on quality assurance and accreditations will be collected from some colleges, universities, Nepal Engineering Council (NEC) and University Grant Commission (UGC).

The study also relies on primary data. Different colleges were visited and conducted informal meeting with relevant and concerning persons of the colleges to know about the internal quality assurance system adopted by the concerning colleges. Similarly, UGC and NEC were also visited and met with responsible dignities to know about their external quality assurance system used in evaluating engineering institutions. Besides, it was also discussed with them about the provision and practices in Nepal about Quality assurance in Engineering Education.

For secondary data relevant and appropriate documents were collected from some colleges, NEC and UGC from one side and from other related documents, research papers and articles were downloaded from different website about quality assurance of engineering education and analyzed thoroughly.

4. RESULT/DISCUSSION

The Engineering profession in Nepal is treated as one of the prestigious profession because of the potential effects of its work in the society. It covers everything from buildings, roads, dams, bridges, airports and railways to industries, computers, software, aircrafts and satellites. Its works cover the entire spectrum of the nation, from the most affluent and urban to the most backward. Engineers have been commanding high respect in the society. Besides, due to the high demand in golf countries and in western countries Nepalese engineers are getting international jobs. So the demand of engineering study is substantially increasing. Hence, to meet the increasing demand of the engineering education, private engineering colleges were established. With the establishment of these colleges, access in engineering education has been increased substantially, but at the same time the quality of education seems deteriorating. Therefore, the issue of quality assurance and accreditation of all engineering institutions seems essential and of great importance.

With the review of documents and discussion with relevant persons of different engineering colleges, universities, NEC and UGC, the provision and practices in Quality assurance in engineering education in Nepal is summarized below.

Different colleges have their own system of operation of the institutions. Most of the colleges have their own policy and procedure on faculty recruitment, faculty development, lesson planning, and provision of extra classes in particular subjects for student upon their request, conduction and coverage of curriculum on time; all are oriented to quality assurance of the education. Most of the institutions have the provision of separate unit like Research and consultancy, Student support and Guidance.

Acme Engineering College has developed and implemented Acme system for smooth operation of the college's activities and aimed at quality assurance of engineering education. The following given are the systems developed and implemented by the college:

1. Procurement System.
2. Item Issue from Store.
3. Communication System.
4. Class Allocation.
5. Gate pass.
6. Sell of practical components.
7. Maintenance Reporting System.
8. Reporting by the person, who attends workshops or seminar.

9. Field Visits.
10. Audio-Visual equipment handling.
11. Remunerations
12. Leaves
13. Medical and Dashain Kharcha.
14. Teachers Evaluation.
15. Students Evaluation.
16. Class Monitoring Format.
17. Monitoring and Evaluation System for Teachers and Staff.
18. Disciplinary monitoring of Students.
19. Teacher / Staff Recruitment System.
20. Guardian Coordination System.
21. Commitment from Full time Teacher.
22. Commitment from Staff
23. Commitment from Students.
24. TOR of Teachers and Staff.

The universities have also the system of periodic monitoring and evaluation of the colleges. They have developed their own checklist for this purpose.

Nepal Engineering Council has developed Check List as per the Norms and Standards for monitoring and evaluation of Engineering Colleges. In the checklist the requirements on different thirteen facilities is mentioned. The first one is Physical Infrastructure. Under this facility, there are 13 components and required areas of each component. They are Land area of the institutions; Rooms (class room, Tutorial room and Drawing hall) area; Laboratory area (10 general lab area and for five specific programs, Civil, Electrical, Electronics and Communication, Mechanical and Computer/IT engineering). Each program has different laboratories and the required area of these laboratories. For Civil engineering there are 11, for Electrical there are five, for Electronics and Communication there are seven, for Mechanical engineering six and for Computer/IT engineering six. The fourth one is Workshop area. The fifth one is Library area, sixth is administrative space, seventh is other amenities, eighth is hostel (optional), ninth is staff accommodation (optional), tenth is play field (minimum two); and last one is area for future expansion.

The second facility is Laboratory equipments. Under this facility number of laboratory requirements and details of equipments and their quantity of each laboratory is given. The laboratories are divided in two major parts namely General and program specific for five different programs. Under general there are seven different laboratories namely: Physics, Chemistry, Communication, Thermal Science, Basic Electrical Engineering, Basic Electronic Engineering and Workshop Practices. The name of equipments and their quantity is given in each of the above mentioned seven laboratories in checklist. Under specific there are five programs mentioned earlier. There are 10 laboratories (Civil Engineering Materials and Concrete Technology; Strength of Materials; Hydraulics; Fluid Mechanics and Hydrology; Surveying; Analysis of Structure; Soil Mechanics; Transportation Engineering; Environmental Engineering; Structural engineering; and Hydropower engineering) and name of equipments and their quantity of each laboratory under civil engineering program. Under electrical engineering program, there are five laboratories (Maintenance Shop; Electrical Machines Laboratory; Measurement, Instrumentation and Control; Basic Circuits; and Power System Engineering) along with the name of equipment and their quantity of each laboratory. There are six laboratories (Electronics Engineering; Advanced Electronics; Electromagnetic & Microwave; Communication; Printed Circuit Board; and Project Work (Optional)) with the name of equipments and quantity of each laboratory under electronics and communication engineering. The forth program is mechanical engineering. There are five laboratories (Thermodynamics & Heat Engineering; Fluid Mechanics and Fluid Machines; Mechanics of Solid; Mechanism and Machine Dynamics; and Instrumentation, Control and Measurement) together with the equipments and their quantity. Under computer engineering, the checklist mentions that the colleges should manage additional required software.

Based on the need and demand for accreditation due to the rapid growth in the number and variety of Higher Education Institutions (HEIs) and programs since the 1990s in Nepal, Quality Assurance and Accreditation Committee (QAAC) was formed for the development and implementation of Quality Assurance and Accreditation (QAA) activities in higher education in Nepal in 2007. The QAA Division in UGC has been established as the permanent functional entity to undertake quality assurance and accreditation related matters and to facilitate QAAC and to perform regular activities related to QAA. The QAAC is responsible for executing quality assessment and accreditation of higher education programs and institutions. The objectives of QAA are to:

1. Facilitate higher education programs, institutions and universities to develop quality assurance mechanisms

by providing formats for self-assessment, peer reviews and quality audits,
2. Recognize the contribution of the various professional councils,
3. Certify the quality of the programs and (HEIs) on the basis of reviews, assessments and audits of the programs and the HEIs,
4. Offer quality advocacy in relation to measuring the equivalency of the various academic degrees earned from the universities across the world,
5. Help the HEIs to assess their strengths, weaknesses, opportunities and threats through an information processing system, and
6. Make QAA a publicly popular move for an overall development of higher education in the country.

As per UGC, participation in QAA is a voluntary process. At present, UGC is running only Institutional Accreditation. Any HEIs which meet the following eligibility criteria can participate in the QAA process:

- HEIs must have at least 50% full time teachers
- Designation of the academic posts listed by the HEI must have been approved by the respective affiliating university.
- Executive head and Head of Departments (HoDs) must be full time teachers
- HEIs must have produced at least 2 batches of graduates or have run graduate programs for 5 years
- In the case of professional HEIs, they should be recognized by the respective professional councils and meet the minimum requirement of the councils.

The scope of QAA covers quality audit, quality assurance and accreditation on the basis of voluntary participation of various higher education institutions including public, communities and private institutions.

QAA procedure consists of a following four–stage process, which is a combination of self-study and peer review:

4.1 Submission of a Letter of Intent (LoI)

The HEIs willing to participate in the QAA process have to submit a Letter of Intent in the specified format (LoI format is given in the website of UGC: www.ugcnepal.edu.np). QAAD will then send the manuals and guidelines to the eligible institutions to complete the entire process of self-assessment.

4.2 Preparation and Submission of Self–Study Report (SSR)

The eligible institution itself has to prepare the Self – Study Report (SSR). Preparation of SSR is an internal exercise for the participating institutions expected to be done with honesty, self-trust and confidence. It aims at providing an opportunity for the institutions to measure their effectiveness and efficiency, and to identify core strengths and weaknesses.

4.3 Peer Review

After receiving the formal SSR report from the participating institution, QAAC forms a Peer Review Team (PRT) to evaluate the QAA status based on the SSR and visit the institution and inspect the patterns of evidence to validate the SSR through observation and interaction with the people concerned in the respective institution. The team also checks the validity and reliability of the information reported in SSR. It also provides a confidential score to facilitate the final grading. The PRT report and the assessment will be discussed in the Technical Committee and will be submitted to QAAC.

4.4 Final Decision for Accreditation

QAAC reviews the PRT report and recommends to UGC for the accreditation status. UGC gives final decision. In case of the accreditation the certification will be valid for a period of five years. The institutions will have to apply for Accreditation and undergo a fresh QAA process after five years. However they may apply it even before the maturity of this period and the process will be started accordingly.

QAA process is completed through the process of Self- Assessment and Peer Review using defined criteria. As currently UGC is undertaking only institutional assessment and accreditation. It has defined generic criteria only. The following given are eight different generic criteria, based on which assessment of institutions are being done by UGC:

1. Policy and Procedures
2. Curricular Aspects
3. Teaching-Learning and Evaluation
4. Research, Consultancy and Extension
5. Infrastructure and Learning Resources
6. Student Support and Guidance
7. Information System
8. Public Information

5. CONCLUSION/RECOMMENDATIONS

Higher Engineering Education in Nepal is still young. It has a history of about 30 years. Due to the lack of sufficient experiences, it is not progressing as per expectations. To develop engineering education at par of the international level

and enhance the quality of education, quality assurance and accreditation of engineering education in Nepal is essential. Based on this reality, the initiation taken by University Grant Commission (UGC) in this regard is very commendable. Some out from 51 engineering colleges has already got QAA from UGC and remaining engineering colleges are in the process of getting QAA, based on the UGC guideline. The engineering colleges as well as the universities providing engineering education are also taking necessary actions to enhance the quality of engineering education by introducing various quality assurance and accreditation processes.

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